TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

VOLUME XXI.

1933-1934.

WITH SIXTEEN PLATES.

CAPE TOWN:
PUBLISHED BY THE SOCIETY.

1934.

C 33
C 33
v.81

OHIO STATE
UNIVERSITY

Printed in Great Britain by
NEILL & CO., LTD., EDINBURGH

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TRANSACTIONS

OF THE

ROYAL SOCIETY OF SOUTH AFRICA.

VOL. XXI

ON SOME SOUTH AFRICAN FOSSIL PROBOSCIDEA.

By S. H. Haughton, D.Sc., F.R.S.S.Af.

(With Plates I–IV and eight Text-figures.)

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Since the publication of Professor Dart's account of various mammoths and other fossil elephants of the Vaal and Limpopo valleys (S. Afr. Journal of Science, vol. xxvi, 1929, pp. 698–731), the writer has had the opportunity of studying new material belonging to the McGregor Museum, Kimberley, and to the South African Museum. The kindness of Miss M. Wilman, Curator of the former Museum, to whose energy in collecting fossil specimens from the diamondiferous gravels of the Vaal valley a tribute is due, has also enabled him to examine all the material on which Professor Dart based his observations with the exception of the type teeth of *Archidiskodon transvaalensis* and *A. sheppardi*. The necessity arose of endeavouring to ascertain the degree of dental variability within the confines of a single species such as the living South African elephant, and an examination was made of teeth supplied by the South African Museum, the McGregor Museum, and the Kingwilliamstown Museum. Reference to the results obtained is contained in the body of this paper; attention must be drawn here to the need for yet more comparative material. In South Africa there will never again arise such an opportunity as was presented at the time of thinning out the Addo herd of elephants to obtain detailed measurements and drawings of the teeth of some eighty individuals of varying age; but such information as, from time to time, does become available should be properly tabulated. It should, then, ultimately become possible properly

to evaluate those factors that have been used as a basis for the erection of the rather numerous species described.

Archidiskodon cf. *subplanifrons.*

Text-figs. 1, 2.

The Kimberley Museum possesses two teeth (upper molars) from Gong-Gong which can be usefully compared with Osborn's species. The specimens are numbered 4333 (right upper molar) and 4334 (left upper molar), and are in a beautiful state of preservation. The teeth were found by Mr. J. Koorts at a depth of 56 feet in the "Middle Terrace," under a boulder, at a distance of 450 yards from the Vaal River, thus occurring at a depth of from 10–15 feet below the level of the present river-bed. They were presented to the McGregor Museum by Mr. C. Kahanovitz. The measurements, compared with those of the type tooth, are as follows :—

	4333.	4334.	*A. subplanifrons.*
Length	257 mm.	176 mm.	143 mm.
Greatest width . . .	104 ,,	104 ,,	98 ,,
Height of deepest plate .	55 ,,	55 ,,	60 ,,
Number of plates preserved .	9	5	5·5
Thickness of enamel . .	4–4·5 ,,	4–4·5 ,,	..
Length-lamellae quotient .	28·5	29	26
No. of plates in 100 mm. .	3·5–4	..	4

Both teeth are incomplete and considerably worn. The grinding surfaces of the plates are concave posteriorly, whereas in the type of *subplanifrons* they are concave anteriorly. In the posterior part of the tooth there is abundant interlamellar cementum ; but in the anterior part, where the plates are worn almost to the roots, the lamellae are much closer together and almost touch throughout. The plates thus taper considerably from the base upwards, and also contract markedly in transverse width. There are no valleculae in the interlamellar cementum.

The posterior talon shows two islets, and is slightly worn ; the last plate shows four, with possibly a subsidiary fifth ; the penultimate plate has five islets. Each plate seems to have consisted originally of five columns, increase in width being attained by the elongation of the grinding surface of the two outside columns, in conformity with the increase in transverse width of the plate towards the base. The central columns show traces of fore and aft buttresses, the anterior buttresses arising prior

to the posterior. The enamel is thick, but not strongly crimped. In the type of *subplanifrons* the number of columns in each plate is greater.

The teeth obviously belong to a low-crowned, broad-plated, heavily

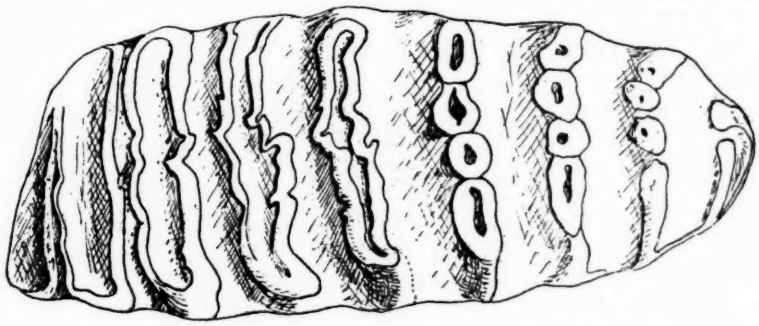

FIG. 1.—Crown view of tooth of *Archidiskodon* cf. *subplanifrons* Osborn. (Kimb. Mus. 4333.)

cemented type such as *subplanifrons*. From the type of *subplanifrons* these teeth differ in having their plates more widely separated, in the lesser number of columns forming the plate, and in the direction of con-

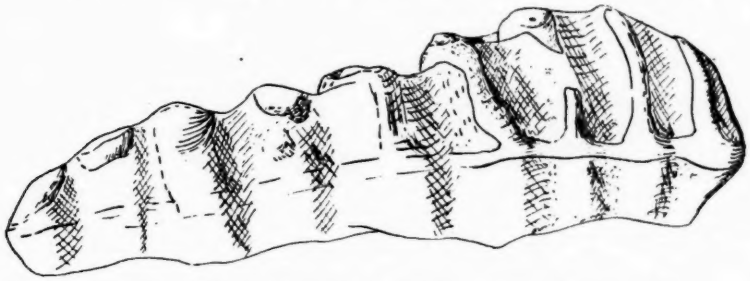

FIG. 2.—Lateral view of tooth of *Archidiskodon* cf. *subplanifrons* Osborn. (Kimb. Mus. 4333.)

cavity of the grinding surface. The loxodont sinus, too, is scarcely so pronounced as in the type of Osborn's species, although this is a variable character, being more clearly shown in one than in the other of these two teeth, which are obviously a pair from one individual.

The only other low tooth described from South Africa is *A. andrewsi* Dart. This is founded on two unsatisfactory fragments, from a depth of 80 feet at Gong-Gong, which show a height of 60 mm. and a probable greatest width of 80 mm. The enamel is markedly but coarsely folded,

and there is a " lack and almost total absence of interlamellar cementum " (Dart, 1929). Dart stresses the Stegodontine characters of this form, and considers *andrewsi* to be the earliest known Archidiskodont from South Africa. It is evident that the two teeth under review cannot be associated with that species, and must either be considered as belonging to *subplanifrons* or to an unnamed species. In view of the known variation possible in such a species as *Loxodonta africana*, the teeth are considered as closely comparable with *Archidiskodon subplanifrons*.

Pilgrimia archidiskodontoides sp. nov.

Plates I–III.

In June 1930, Miss Wilman, the Curator of the McGregor Museum at Kimberley, forwarded to the writer for examination a collection of fragmentary mammalian remains which had been found by Mr. J. du Preez, jun., at the Sydney-on-Vaal Breakwater in the bed of the Vaal River, 10½ feet " below the maiden ground." In February 1931, thanks to the mediation of Major H. P. Tuckey, Miss Wilman received a further consignment, from the same locality, of material which was in the possession of Mr. J. J. de Jong. Among the heterogeneous collection of bones which made up these two consignments, the writer discovered some Elephantid remains—a fragmentary skull with two worn molars that can be fitted into their sockets, a humerus which lacks the proximal end, the glenoid portion of a scapula, and the fairly complete left side of a pelvis. These are the bones that are briefly described and figured here.

Teeth.—Both the left and right upper molars are preserved, both showing very worn grinding surfaces. From the fact that the socket into which the right tooth fits is bounded posteriorly by a wall of bone with a thickened and somewhat rugose ventral surface, and further that posterior to this wall is another, unfilled, socket, it is concluded that the teeth are the second permanent molars.

The left molar has nine plates and a posterior talon preserved. The three anterior plates are worn down to the roots, so that the enamel of each has coalesced with that of the succeeding plate. The degree of wearing is greater on the inner than on the outer side of the tooth. As preserved, the length of the tooth is 148 mm.; the greatest breadth was probably 94 mm.; the maximum thickness of the plates (4th and 5th) is 16 mm.; the height of the posterior plate is about 145 mm. The length of the posterior six plates is 107 mm.; and six and a half plates occur in a length of 100 mm.

The plates are close together, with very little interlamellar cement except at the edges. It is probable that the plates were narrower laterally

than medially. There is no evidence of any tendency to the formation of a median loxodont buttress.

The lamellae are wider at the base than on the grinding surface, their width thus increasing as wear proceeds. The enamel is of medium thickness (2·5–3 mm.), and is by no means strongly crimped.

In the right molar the posterior talon is missing. Five plates occupy 80 mm., and there is very little interlamellar cement. The plates have their anterior and posterior faces roughly parallel, there being no marked antero-posterior thickening of the plate towards the root. Laterally there is a distance of 15 mm. from mid-point to mid-point of succeeding enamel ridge plates.

Although they are wider than any of the three species described by Dart, these teeth seem—on account of their high lamellar frequency—to fall within the limits of the genus *Pilgrimia*. In the forms of *Archidiskodon* from South Africa described by Osborn and by Dart, the lamellar frequency (*i.e.* the number of plates occurring within a standard length of 100 mm.) ranges from 3–3·5 in *A. vanalpheni* to 4·5–5·5 in the hypsodont *A. hanekomi*; and the respective ratios of length-lamellae are 31·2 and 18·2. In *Pilgrimia* the frequency is 5–6 in *P. yorki* and 6·5 in *P. wilmani*; and the length-lamellae ratio is 18·2 in the former and 16 in the latter. In the form under discussion the figures are 6·5 and 15·4–15·6 respectively. The greater width of the two teeth described here tends to remove them from *Pilgrimia* as hitherto known in South Africa. Width, however, is a somewhat varying quantity within a species, as is evidenced by a study of a large number of molars of *Loxodonta africana* where the width varied from 60 mm. to 84 mm., and is dependent on the position and seriation of the tooth. Teeth from the lower jaw are always narrower than teeth from the upper jaw; and the upper molars of *Pilgrimia yorki* will certainly be found to be broader than 79 mm., which is the measurement given by the type lower molar. A breadth of 94 mm. is obviously not an impossibility for a *Pilgrimia* upper tooth.

That the form differs from any of the teeth of *Pilgrimia* hitherto described from South Africa is evident. In its breadth and in the tapering form of its plates it recalls certain forms of *Archidiskodon* such as *A. yorki*; and I propose, therefore, for the sake of convenience, to designate it by the new name *Pilgrimia archidiskodontoides*.

In the following table, measurements are given of most of the described fossil forms from South Africa, together with the lamellar frequency and the length-lamellar ratio. Where the measurements differ from those given by Dart, the reason is that they refer to different distances. In this table the length given excludes any posterior or anterior cement, and is taken longitudinally; it is not the "greatest length." Similarly, the

" height " is the height of the deepest plate, exclusive of roots, and is measured from the bottom of the enamel to the grinding surface. The columns refer to the following particulars :—

A—Number of lamellae preserved.
B—Length of molar.
C—Greatest breadth of widest lamella.
D—Height of deepest plate.
E—Lamellar frequency.
F—Length-lamellae ratio.

The forms are arranged in order of increasing lamellar frequency.

Name.	A.	B.	C.	D.	E.	F.
Archidiskodon vanalpheni Dart	7 ×	234	112	115	3–3·5	31·2
A. milletti Dart . . .	× 7	206	106	117	3·5	29·4
A. loxodontoides Dart . .	4½	132	92	87	3·5	29·4
A. broomi Osborn . .	6	168	107	130	3·5–4	28·0
A. subplanifrons Osborn .	5½	143	98	60	4	26·0
A. hanekomi Dart . .	16	308	102	210	4·5–5·5	18·2
Pilgrimia kuhni Dart . .	5	93	75	100	6 ?	18·6
P. yorki Dart . . .	9	164	79	96	5–6	18·2
P. wilmani Dart . . .	7	112	70	123	6·5	16·0
P. archidiskodontoides nov. .	7	108	94	98	6·5	15·4
	9 ×	148	94	145	6·5	15·6

For purposes of comparison, figures are given for a number of molars of *Loxodonta africana*. For permission to examine some of these thanks are due to Miss M. Wilman of the Kimberley Museum and to Capt. G. C. Shortridge of the Kingwilliamstown Museum.

A.	B.	C.	D.	E.	F.
6	158	75	150	4	26·3
11	275	84	144	3·5–4	25·0
7 ×	182	70	138	4	24·2
9	203	75	95	4–4·5	22·5
8 ×	189	66	85	4–4·5	22·3
8	168	60	78	4·6–5·2	21·0
× 9 ×	203	63	65	4·2–4·8	20·3
9	180	70	92	4·5–5·3	20·0
11 ×	205	63	96	4·6–5·3	18·6

Skull.—A portion of the maxillae, into which the two molars fit, is preserved. It shows that the palate was narrow and vaulted, and that the molars diverged posteriorly. In front the width between the molars is about 50 mm., and at the back it was about 90 mm. The vault of the palate is 60 mm. above the grinding surface of the teeth. The alveoli of the tooth in use and the succeeding molar are separated by a wall of spongy bone, which is thicker ventrally than dorsally. In front of the molar, the palatal surface of the maxilla is strongly hollowed—a feature that is not seen in the skulls of *Loxodonta africana* that have been examined.

Humerus.—Part of a right humerus is preserved, the bone lacking the proximal end. Its chief features can easily be discerned from the illustrations given. The bone is much more robust than that of *Loxodonta africana*. The shaft is thicker, and the deltoid crest much stronger and more prominent. The supinator crest is, proportionately, of about the same length; but, as in *P. antiqua recki*, its border is straight and has not the curved form with upper protuberance that is seen in *L. africana*.

In actual size the bone is smaller than that of *P. antiqua recki* and that of *P. antiqua andrewsi*. Its chief measurements are :—

	mm.	II.	III.	IV.
Maximum width, distal end . .	265 +	350	350	227
Width, trochlear articular surface .	230	285	306	..
Height of top of supinator crest above distal end	267	410 ?	450	275
Minimum thickness of shaft . .	125	145	167	80

Comparative measurements of other forms are given in parallel columns.

II—*P. antiqua recki* from Oldoway, East Africa.
III—*P. antiqua andrewsi* from Upnor, England.
IV—*Loxodonta africana* from Addo.

Although the head of the bone is not preserved, it can be seen that the inner border is more strongly bowed than in *L. africana*, and it is concluded that the caput humeri was larger or stood away further from the main axis of the bone than in the modern form.

Pelvis.—The left side of the pelvis is almost entire, lacking most of the ischium, the symphyseal region, and the upper iliac crest.

In shape, the ilium differs considerably from that of *P. antiqua recki* as figured by Dietrich. The pre-acetabular portion of the iliac plate is considerably longer; at the narrowest part of the shaft the outer face of

the bone is practically flat, and above this the outer face is far less concave than in the East African form. From the ilium of *L. africana* this bone differs very considerably.

The pubis has a much stouter shaft than in either *P. antiqua recki* or *L. africana*. In view of the broken nature of the borders of the specimen it is not possible to give many measurements; but the following show some of the differences between this specimen and that of a male *L. africana* from Addo.

	P. archidiskodontoides.	*L. africana.*
	mm.	mm.
Greatest length of iliac blade . .	(As preserved) 680	646
Distance from supra-acetabular ridge to spina anterior	386	230
Thickness of ilium at spina anterior .	145	85
Height of acetabulum . . .	214	150
Width of acetabulum . . .	200	144

Pilgrimia subantiqua sp. nov.

Plate IV.

From Delport's Hope comes a lower molar, now in the possession of the Kimberley Museum, which Professor Dart (*in litt.* 12th February, 1930) provisionally assigned to *Archidiskodon transvaalensis*. In the opinion of the present writer, the tooth—on account of its low-crowned nature—is definitely distinct from the high-crowned *transvaalensis*.

The specimen is numbered 4286 in the Kimberley Museum, to which institution it was presented by Mr. G. Barrell. The tooth is said to have been found at a depth of 40 feet in the "higher terrace" at Delport's Hope, half a mile from the Vaal River.

The tooth is possibly a right lower molar, probably the second, and its grinding surface is strongly concave in an antero-posterior direction. Eleven plates are preserved, of which the first has been worn down to the roots, and the last is just coming into wear. There was probably a posterior talon. The plates are fully covered with cementum both on their medial and lateral sides. The greatest length of the tooth as preserved, including the posterior cementum, is 245 mm. Measured in a straight line, the ten and a half plates visible on the grinding surface occupy 206 mm., giving a length-lamellae quotient of 19·5. The lamellar frequency varies from 4·75 in the front part of the tooth to 5·75 in the back part, so that the

individual lamellae increase in thickness towards the root. They also taper in width upwards. The maximum thickness of a plate (4th) is 19 mm., and the minimum thickness of interlamellar cementum is 4 mm. The greatest width (including cementum) is 92·5 mm., and the maximum width of a plate at the grinding surface 79 mm. The enamel is not thick and is coarsely crimped.

The tooth is low. The greatest height of any plate preserved, above the roots, is about 75 mm., and it is doubtful if the maximum height of any of the posterior plates exceeded 85–90 mm.

The last plate shows two columns on the grinding surface; the penultimate shows four islets, of which the second from the outside is formed by the fusion of two columns. The median column shows a short posterior spur, and the one lateral to it has a similar anterior spur. In the antepenultimate plate there are again four islets, of which the median two show both anterior and posterior spurs. These spurs increase in number in the plates as one goes forward to the middle of the tooth. Thence onwards the lamellae show slightly crescentic grinding faces, concave anteriorly, and having their medial ends rather more truncate than the lateral ends. The details can be seen in the illustrations given.

The tooth, when viewed on the grinding surface, bears a strong general resemblance to the upper molar of *Pilgrimia antiqua andrewsi* figured by Forster-Cooper ("The Upnor Elephant," 1928). There the upper tooth has twelve plates with a posterior talon, is 221 mm. long, 83 mm. broad, and has a lamellar frequency of 5–5·5. The height, however, is greater than in the Delport's Hope molar. The lower molar of *andrewsi* is narrower and lower; but even it is higher than the tooth under discussion, and it shows a well-marked loxodont pattern.

In its lamellar frequency this tooth shows a higher number than any of the teeth of *Archidiskodon* yet described from South Africa with the exception of *A. hanekomi*, from which it obviously differs considerably; but its figure is less than that of the forms of *Pilgrimia* from the Vaal River area, approximating most closely to that of *P. yorki*. According to the figures given by A. T. Hopwood (Uganda Geol. Surv. Occ., Paper 2, 1926), the lower molars of *Pilgrimia antiqua zulu* have a lamellar frequency of from 4·7 to 4·9, but differ from this tooth in the greater thickness of the enamel and in their somewhat greater height. The examples of *zulu*, too, from Kaiso are distinctly narrower. It is possible that the Delport's Hope molar is from the upper jaw, in which case its low-crowned character becomes even more pronounced.

As far as the evidence of a single tooth can go, it would seem that we are dealing here with a somewhat primitive member of the *Pilgrimia antiqua* group, characterised by its low-crown, thin enamel, rather lati-

coronate character, and absence of a loxodont sinus. Its low lamellar frequency distinguishes it from the Pilgrimids described by Dart, and its height is very much less than that of *P. antiqua recki*. Its tapinodiscal character seems to give it a place in the Pilgrimid phylum comparable with that which *A. subplanifrons* occupies in the Archidiskodont phylum; and it is proposed, therefore, to designate the tooth as the type of a new form *Pilgrimia subantiqua*.

Pilgrimia sp.

Text-fig. 3.

In a recent paper on the fossil species of *Equus* occurring in South Africa reference was made to the finding at Usakos, South-West Africa, of proboscidean molars together with teeth of *Equus sandwithi*. These molars are, unfortunately, rather fragmentary; but careful examination shows the presence of parts of four teeth, of which one is worthy of description.

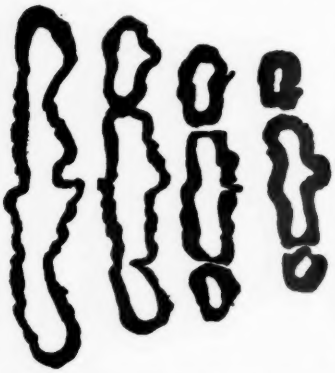

FIG. 3.—Enamel pattern on 4 plates of *Pilgrimia* sp.

The tooth in question (South African Museum, No. 6579) consists of four complete plates showing the grinding surface and of parts of two others, probably originally in contiguity with the four, whose grinding surface has been lost. By comparison with the other fragments, it appears probable that this tooth is a lower molar.

At the grinding surface the length of the four complete plates is 51 mm.; at the roots the length is 71 mm. The breadth of the plates at the grinding surface is 56 mm. for the anterior and 40 mm. for the posterior plate. Each plate is widest just above the roots, and then narrows rather rapidly. The maximum width of any plate is 71 mm. The probable length of six plates on the grinding surface is 78 mm., so that the length-lamellae ratio is 13. Maximum height of deepest plate 86 mm.

The plates are set closely together, and the amount of interlamellar cement is small. The anterior face of each lamella is flat, save for numerous small longitudinal ridges; the posterior face is furnished with a weak median buttress. Both faces and ends of the plates are strongly rugose. The development of the plates shows that each has a large central island flanked on either side by a small rounded islet.

A second fragment, showing five plates and a posterior talon, is probably the posterior part of the corresponding molar of the opposite side of the lower jaw. The anterior three plates are just coming into wear, and they show that the central island mentioned above is formed by the coalescence of six small islets.

Insufficient of the upper molars is preserved to be of diagnostic value. They are seen to possess plates of the same general character as those described, similarly closely set together, but higher and wider than those of the lower molars.

The form obviously differs from any hitherto described from South Africa, particularly in its high lamellar frequency; *Pilgrimia wilmani* and *P. loxodontoides* are the forms which come closest in this respect. For the present, in spite of its geographic isolation, it will probably be better to refrain from giving it a specific name.

Loxodonta africana.

Plate IV, Text-figs. 4–8.

Among material presented to the Kimberley Museum by Mr. C. E. Stewart, found by him on the floor of a pan at Morokwen, Bechuanaland, is a well-preserved left upper molar of an elephant. This was associated with teeth of *Rhinoceros bicornis* and of *Equus quagga burchelli*. Examination of this tooth has raised questions as to the extent of variability in the molars of the South African elephant, and some facts concerning this may be set down here.

The tooth from Morokwen, as preserved, has eleven lamellae and a single-columned posterior talon. It is possible that an anterior ridge may originally have been present, so that its complete ridge-formula would have been $\times 12 \times$. The length as preserved is 238 mm., and possibly was originally 250–260 mm. The maximum width of enamel on the grinding surface is 73 mm., on the 4th ridge-plate preserved; the maximum width of the tooth is 77 mm. The last two ridges and the talon are unworn, the anterior ridges strongly worn. The height of the 10th ridge preserved is 90 mm., and of the 9th ridge 94 mm.

The enamel on the worn surface is thick (3–3·5 mm.) and fairly strongly plicated. As a result of wear, the ridge-plates broaden considerably at the ends, so that the cross-section of the anterior plates becomes an elongate hexagon in shape. Posteriorly, the slightly worn plates have an irregularly triangular shape, with the loxodont sinus appearing at the anterior apex of the triangle.

The lamellae are distinctly narrower medially than laterally. The lateral end is squarely truncated; but medially the plate is more pointed

and tends to turn backwards. On the medial side the ridge-plates are completely enclosed in abundant cementum; but laterally there are interlamellar valleculae, and the ridges have rugged grooved ends. The median anterior buttress is much more prominent than the posterior one; but it is not until an advanced stage of wear is reached that the interlamellar cementum is divided by the median abutment of two adjacent plates.

Dart has already pointed out the necessity for further information on the dental anatomy of the living and fossil varieties of the African elephant, with a view to determining the amount of variation that occurs. It is interesting here to note that a tooth of the living species *L. africana* from Addo (now in the Kimberley Museum) shows characters that are those on

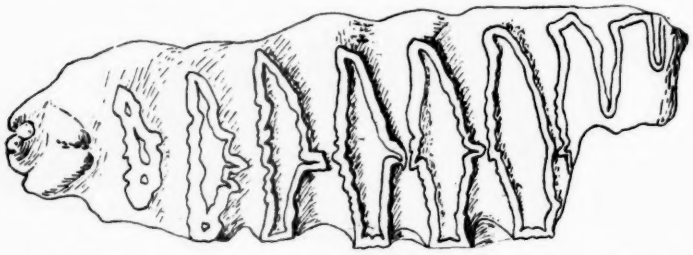

FIG. 4.—Crown view of tooth of *Loxodonta africana* from Morokwen. (Kimb. Mus.)

which Dart founded his variety *L. africana obliqua*. Other teeth from Addo which have been examined do not show these features to the same extent, if at all; but as there can be no doubt of the racial unity of the Addo elephants, the foundations upon which Dart built his variety *obliqua* are seen to be insecure.

Considerable variation is possible within the confines of a race, as is evident from the examination of the teeth of two elephants from Knysna now in the South African Museum. These are numbered 15844 and 16195, and drawings of their molars are given here. In the former skull the last molar is in use, with the posterior plates not yet erupted: in the other skull the molar in use is probably the penultimate. It can be seen, however, that the features considered by Dart as varietal are variable within a distinct race. For example, in the upper molar of 15844 the ends of the worn plates are much squarer than in 16195, and there is a greater accentuation of the anterior buttress compared with the posterior in 16195 than in 15844. This latter difference is even stronger in the lower molars; 16195 shows its posterior plates concave posteriorly and its anterior plates with squared ends, the medial side broader than the lateral and having a posterior

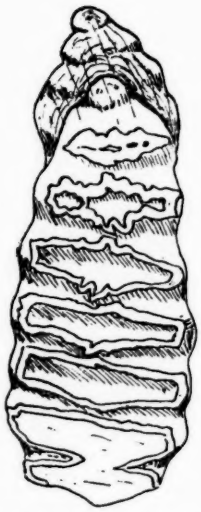

FIG. 5.—Upper molar of *Loxodonta africana* from Knysna. (S. Afr. Mus. 15844.)

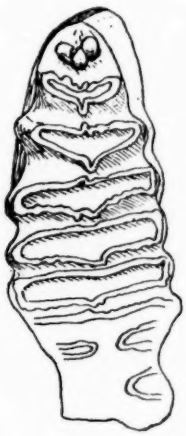

FIG. 6.—Upper molar of *Loxodonta africana* from Knysna. (S. Afr. Mus. 16195.)

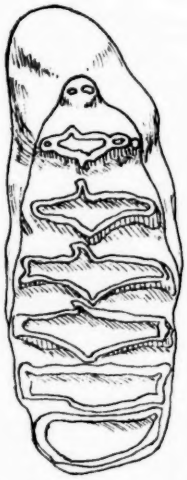

FIG. 7.—Lower molar of *Loxodonta africana* from Knysna. (S. Afr. Mus. 15844.)

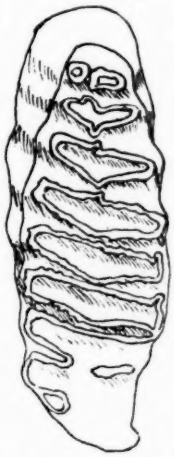

FIG. 8.—Lower molar of *Loxodonta africana* from Knysna. (S. Afr. Mus. 16195.)

spur ; 15844 has its posterior plates concave anteriorly, and its anterior plates with subequal truncate ends. Both animals show a tendency to the obliquity of the plates that was figured by Owen and remarked upon by Dart.

It is possible that the tooth from Morokwen may belong to the living race *selousi*, whose type habitat is Mashonaland ; but of the dental features of that race no details have been published. Dr. G. Arnold has been good enough to send drawings and measurements of the teeth of a skull from an animal " undoubtedly shot in Southern Rhodesia," and now in the Rhodesia Museum. The Morokwen tooth is considerably wider than this, and the patterns of the ridge-plates differ considerably. The Morokwen tooth certainly differs from those of the Knysna and Addo elephants ; but further specimens of the South-West African race and of the Rhodesian race must be examined before its exact position can be defined.

Geological Observations.

The most ancient gravels which have hitherto yielded elephantid remains in South Africa are the deep gravels of the Middle Terrace of the Vaal River whence, from a depth said to be 80 feet, came the fragmentary tooth described by Dart as *Archidiskodon andrewsi*, as well as *A. milletti* and *A. vanalpheni*.

This " Middle Terrace " is often referred to as the " 60–80-foot terrace," and no competent observer has given its maximum height above the present level of the Vaal River as anything greater than 80 feet. If, therefore, the gravels are 80 feet thick in parts of this terrace, it is apparent that before the period of aggradation denoted by these gravels the Vaal River had cut at least part of its bed to the level that it occupies to-day. It becomes, therefore, necessary to inquire rather more closely than has hitherto been done into the age-relationships of the gravels of this " Middle Terrace " and the so-called " River-bed Gravels," and, in particular, of the so-called " D " gravels of Sheppard Island.

Dart, in his description of the various mammoth teeth from the Vaal River area, has considered that the " D " gravel is of much more recent origin than the gravels of the Middle Terrace. The teeth from the former —*Archidiskodon transvaalensis* and *A. sheppardi*—are considered by Dart as the fifth local phase of mammoth progression, and are placed in the Upper Pleistocene by Osborn ; while *A. andrewsi* (from 80 feet down in the Middle Terrace at Gong-Gong) is doubtfully assigned to the Pliocene, representing the first phase of mammoth evolution, and *A. milletti* and *A. vanalpheni* (from 80 feet down in the Middle Terrace at Sydney-on-Vaal) are considered as the second phase and are also tentatively assigned to the

Pliocene. This sequence of beds, if accepted, presumes that, before the deposition of the lowest gravels of the Middle Terrace, the river had cut its bed down at least to its present level; that aggradation had then resulted in the deposition of at least 80 feet of gravels; that renewed downward-cutting had then taken place with the subsequent sequence of events that resulted in the formation of the "River-bed" gravels and their partial erosion.

It must be emphasised that the earliest date that can be assigned to any undisturbed river-gravel is the date at which the lowest beds in a continuous sequence were deposited; and that comparisons between gravels at varying distances from a river or at various places along a river valley should be based upon the altitude of the bottom-bed of each deposit with respect to the present river-level, and not upon that of the top of the gravel.

Both at Barkly West and in the stretch of the Vaal River between Waldeck's Plant and Delport's Hope the so-called "Middle Terrace," as far as the scanty evidence put on record permits one to judge, is not far from the present river-channel; and at each of the places whence fossils or stone implements have been recorded from the gravels of this terrace, the base of the gravels is, at the most, only a few feet above present river-bed level. At Canteen Kop, near Barkly West, the terrace is said to be about 30 feet high, and gravels occur to a depth of 24 feet in it, although, according to du Toit, the platform supporting the gravel stands at between 13 and 16 feet; at Niekerk's Rush gravels carrying implements of Stellenbosch type occur 20 feet down in gravels whose upper level is not stated; at Gong-Gong, as already pointed out, teeth from a depth of 80 feet from the top of the "Middle Terrace" are recorded; and at Sydney-on-Vaal a similar depth of gravel is known. The last locality is stated by Mr. van Alphen to be only "25 to 30 yards from the present river." It is apparent that the gravels of the "Middle Terrace" have their base at, or very near to, the present river-level.

The supposedly later "River Gravels" fringe the present river-bed, or are actually within it. At Sheppard Island (near Bloemhof) there is an older gravel (the "D" gravel of van Riet Lowe) carrying implements of the Upper Stellenbosch culture, two species of *Archidiskodon* and *Equus sandwithi*, overlain unconformably by a newer "C" gravel (containing a Fauresmith culture), which is itself covered by clay and sand. At the Vanaswegenshoek site near Christiana, according to Dart, 13 feet of gravel lie below present river-level in an old channel; this gravel can be divided into five layers, of which the lowest and middle beds are fossiliferous, the former carrying two species of *Pilgrimia* and the latter *Archidiskodon yorki*, which is considered by Dart to be derived from an earlier deposit in

the " Middle Terrace." At Riverton and at Pniel Mission Station, the gravels lie in the present bed of the river, and contain implements of Stellenbosch type. From a depth of 8 feet in these gravels at Pniel came the type of *Archidiskodon broomi*—considered by Dart to be possibly re-interred after the denudation of an earlier gravel of the " Middle Terrace." At Sydney-on-Vaal—where the 60–80-foot terrace is preserved—there are also gravels in the river-bed which, at a depth of 10½ feet, yielded the bones of *Pilgrimia archidiskodontoides* ; whilst the type of *Archidiskodon hanekomi* is said to have come from a depth of 20 feet in the river-bed gravels of Delport's Hope.

Consideration of these facts leads to the acceptance of a possibility that we are dealing with one sequence of gravels and not with two ; that the deepest of the " river-bed gravels " are the equivalent of the deepest of the " Middle Terrace " gravel. This implies one period of aggradation, during which successive layers of gravel were piled one upon another, the upper layers being of more recent origin than the lower, with subsequent erosion by the river through its own gravels, accompanied by minor oscillations such as were postulated by van Riet Lowe to account for the stratigraphy at Sheppard Island. To obtain proof of the truth of such a possibility, which du Toit seems to have envisaged first, it is necessary that a detailed geological examination be made of an area such as Sydney-on-Vaal, where the two gravels occur in close proximity, and to construct accurate sections in a direction at right angles to the present river-bed in order to ascertain whether the gravels of the " Middle Terrace " occupy a definite channel distinct from that occupied by the " river-bed " gravels, or are not in reality both part of the same succession.

Evidence in favour of this view is supplied by the stone implements. According to Goodwin, the implements from the gravels at Canteen Kop (which rest upon a platform 13–16 feet above low-water) are " exactly similar to other Vaal River specimens," the majority of which come from the river-bed gravels. The thickness of gravels at Canteen Kop is some 24 feet ; and, if the theory of two periods of gravel deposition is to be accepted, we are involved in the conclusion that the Stellenbosch industry existed in the same area right through the period of deposition of these gravels, through the subsequent downward erosion period of the Vaal, and the formation of the later " river-bed " gravels, in which, as at Sheppard Island (" D " gravel), Pniel, and elsewhere, rolled and unrolled implements of Stellenbosch type are found unmixed with any of later culture.

Against this view is the conclusion of Dart with regard to the sequence of events in mammoth evolution in the Vaal valley, a sequence which visualises a succession of forms from bottom to top of the " Middle Terrace " gravel followed by a series of later stages found in the " river-bed gravel."

This sequence has its exceptions, *e.g.* the occurrence of the supposedly advanced and highly specialised *A. hanekomi* in the bottom layers of the second group of gravels; and it becomes necessary to presume that *A. broomi* and other less advanced types found higher up in the same gravels are derived from pre-existing deposits. It is scarcely possible in this case to determine to what extent the supposed relative ages of the various gravels have been determined by the mammoth sequence, or the supposed mammoth sequence by the relative ages of the gravels; but it seems certain that, so long as but fragmentary remains of teeth are the only fossils known, the geological facts should hold pride of place in determining the true sequence, if they can be accurately determined.

Dr. Rogers has well pointed out that the actual thickness of the gravel and the actual height of any particular horizon above the present river-level are no exact criteria of age unless they be considered in conjunction with other factors. Of these the most important is the geological nature of the river-bed at the time of deposition. The Vaal River, in the stretch under consideration, runs over rocks of varying degrees of hardness, and has thus been enabled to erode its bed unequally, cutting a deeper channel upstream of rises of hard Ventersdorp rocks than it would have done were the rock bottom uniform. This must have led, during any period of aggradation, to lack of uniformity in the deposition of sediment. Taken together with the possibilities of variation due to periodical changes in the water-supply and in the consequent transporting power of the river, it can well be understood that much detailed investigation is necessary before the true sequence of events can be elucidated.

[Explanation of Plates.

EXPLANATION OF PLATES.

Plate I.

Pilgrimia archidiskodontoides Htn.

Fig. 1. Crown view of molar.
Fig. 2. Portion of skull showing palate, with molar in place.
Fig. 3. Left side of pelvis, anterior view.

Plate II.

Pilgrimia archidiskodontoides Htn.

Fig. 1. Right humerus, anterior view.
Fig. 2. Right humerus, posterior view.

Plate III.

Pilgrimia archidiskodontoides Htn.

Fig. 1. Left side of pelvis, medial view.
Fig. 2. Left side of pelvis, acetabular view.

Plate IV.

Fig. 1. Cast of type tooth of *Pilgrimia subantigua* Htn., crown view.
Fig. 2. Cast of type tooth of *Pilgrimia subantigua* Htn., lateral view.
Fig. 3. Tooth of *Loxodonta africana*, from Addo (Kimberley Mus.). (For comparison with fig. 4.)
Fig. 4. Cast of type tooth of *L. africana* var. *obliqua* Dart.

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NOTE ON SETS OF ORTHOGONALLY RELATED VARIABLES.

By Sir Thomas Muir, F.R.S.

1. Our first concern here is with the multiplication of linear homogeneous functions of one and the same set of variables, the special matter concentrated on being the finding of any desired part of the product without having to be troubled with all the rest,—the finding, for example, of the term y^2z belonging to the product of three linear homogeneous functions of x, y, z.

2. Denoting the functions by

$$a_1x + a_2y + a_3z$$
$$b_1x + b_2y + b_3z$$
$$c_1x + c_2y + c_3z,$$

—and much of course as usual depends on our notation—we see that every term of the product must contain an a and a b and a c, and that any term containing x must have the suffix 1 in its coefficient, the presence of y similarly entailing the suffix 2 and the presence of z the suffix 3. The desired part of the product must thus be

$$(a_2b_2c_3 + a_2b_3c_2 + a_3b_2c_2)y^2z.$$

3. What this amounts to is that we allow y^2z or yyz to suggest to us 223 : then we take the permutations of 2, 2, 3 : and finally we use each permutation to give us the suffixes of abc : in other words, abc we keep fixed as to order and 223 we permute. In general, of course, this is a different thing from keeping 223 fixed and permuting abc,—the two, in fact, only leading to the same result when it is the term in xyz that is wanted, namely

$$\begin{vmatrix} + & & + \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} xyz,$$

a notation which by the way reminds us that the other coefficients can also be expressed as permanents (Math. from Educ. Times (2), xxii, pp. 49–50).

4. Thus far the linear functions originating our product have been all different: let us now pass from this, and to meet our new requirements let us give them names, say X, Y, Z: or rather let us proceed to the case of four variables, x, y, z, w, denoting the four functions

$$\left.\begin{array}{l} a_1w+a_2x+a_3y+a_4z \\ b_1w+b_2x+b_3y+b_4z \\ c_1w+c_2x+c_3y+c_4z \\ d_1w+d_2x+d_3y+d_4z \end{array}\right| \text{by} \left|\begin{array}{l} \mathrm{W} \\ \mathrm{X} \\ \mathrm{Y} \\ \mathrm{Z}, \end{array}\right.$$

and taking for our example the product $\mathrm{W^2XY}$ and for the desired part of its development the terms in w^2x^2. Reasoning exactly as before we affirm (1) that the product being $\mathrm{W^2XY}$ every term of it must contain two a's, one b, and one c; and (2) that those terms of it that contain w^2x^2 must carry for suffixes two 1's and two 2's. We have thus got to take the permutations of 1122 and suffix each of them to *aabc*: doing which we have the result

$$(a_1a_1b_2c_2+a_1a_2b_1c_2+a_1a_2b_2c_1+a_2a_1b_1c_2+a_2a_1b_2c_1+a_2a_2b_1c_1)w^2x^2,$$

i.e.
$$(a_1{}^2b_2c_2+2a_1a_2b_1c_2+2a_1a_2b_2c_1+a_2{}^2b_1c_1)w^2x^2.$$

Similarly, to obtain the terms in w^3x belonging to the product $\mathrm{W^2XY}$, we permute 1112 and suffix each permutation to *aabc*, with the result

$$(a_1a_1b_1c_2+a_1a_1b_2c_1+a_1a_2b_1c_1+a_2a_1b_1c_1)w^3x,$$

i.e.
$$(a_1{}^2b_1c_2+a_1{}^2b_2c_1+2a_1a_2b_1c_1)w^2x.$$

5. Next let us depart from generality in our given linear functions, making the important specialization in which they are the linear functions of an *orthogonal transformation*, and calling them when so specialized ω, ξ, η, ζ. It is then known that simultaneously with the given set of equations

$$\left.\begin{array}{l} \omega=a_1w+a_2x+a_3y+a_4z \\ \xi=b_1w+b_2x+b_3y+b_4z \\ \eta=c_1w+c_2x+c_3y+c_4z \\ \zeta=d_1w+d_2x+d_3y+d_4z \end{array}\right| \text{we have the converse set} \left|\begin{array}{l} w=a_1\omega+b_1\xi+c_1\eta+d_1\zeta \\ x=a_2\omega+b_2\xi+c_2\eta+d_2\zeta \\ y=a_3\omega+b_3\xi+c_3\eta+d_3\zeta \\ z=a_4\omega+b_4\xi+c_4\eta+d_4\zeta, \end{array}\right.$$

the determinant of the one being the conjugate of that of the other: and it is at once clear that any result we may have already reached in regard to the former set must hold also when we make the interchange

$$\begin{pmatrix} w & x & y & z \\ \omega & \xi & \eta & \zeta \end{pmatrix}$$

and substitute for each coefficient its conjugate in the determinant. For example, having shown that

$$\text{the cofactor of } w^3x \text{ in } \omega^2\xi\eta \text{ is } a_1{}^2b_1c_2 + a_1{}^2b_2c_1 + 2a_1a_2b_1c_1$$

we deduce that

$$\text{the cofactor of } \omega^3\xi \text{ in } w^2xy \text{ is } a_1{}^2a_2b_3 + a_1{}^2b_2a_3 + 2a_1a_2a_3b_1.$$

6. Such deductions, however, we may also arrive at directly from inspection of the set of equations, just as before. Thus, to take the same example,—the cofactor of $\omega^3\xi$ in w^2xy—we see that the product of linears being w^2xy, every term in it must bear the suffixes 1123, and that the variables in our term being $\omega\omega\omega\xi$ the coefficient-letters in the term must be *aaab*. Permuting *aaab*, therefore, and keeping 1123 fixed we have

$$a_1a_1a_2b_3 + a_1a_1b_2a_3 + a_1b_1a_2a_3 + b_1a_1a_2a_3,$$

i.e.

$$a_1{}^2a_2b_3 + a_1{}^2a_3b_2 + 2a_1a_2a_3b_1,$$

as before.

7. A still more interesting consequence of the existence of orthogonal relationship between the two sets of variables is suggested if as another example we seek for the cofactor of $\omega^2\xi\eta$ in w^3x. Looking at the function-product *wwwx* we see that every term of its expansion must bear the suffixes 1112, and that those of them containing $\omega^2\xi\eta$ must have the coefficient-letters *aabc* : this means permutation of *aabc* and keeping 1112 fixed, which gives us

$$a_1a_1b_1c_2 + a_1a_1c_1b_2 + a_1b_1a_1c_2 + a_1b_1c_1a_2 + a_1c_1a_1b_2 + a_1c_1b_1a_2$$
$$+ b_1a_1a_1c_2 + b_1a_1c_1a_2 + b_1c_1a_1a_2 + c_1a_1a_1b_2 + c_1a_1b_1a_2 + c_1b_1a_1a_2,$$

i.e.

$$3(a_1{}^2b_1c_2 + a_1{}^2b_2c_1 + 2a_1a_2b_1c_1).$$

And comparing this result with that used in the preceding paragraph we see that we have reached the curious equality

$$\text{cof. of } w^3x \text{ in } \omega^2\xi\eta = \tfrac{1}{3}(\text{cof. of } \omega^2\xi\eta \text{ in } w^3x).$$

8. Some such semblance of reciprocity was a thing to be looked for, when we chose to connect the idea of orthogonal substitution with our set of linear functions ; and the form which the reciprocity might take was partly foreshadowed when the relation between the mode of finding the cofactor of w^3x in $\omega^2\xi\eta$ and the mode of finding the cofactor of $\omega^2\xi\eta$ in w^3x made its appearance. We could hardly, however, hope for the existence of so wide a property as the following : *If two sets of* n *variables* x, y, z, . . . *and* ξ, η, ζ, . . . *be orthogonally connected, then the coefficient of* $x^a y^b z^c \ldots$

in $\xi^a\eta^\beta\zeta^\gamma \ldots$ *is, save for an arithmetical factor, equal to the coefficient of* $\xi^a\eta^\beta\zeta^\gamma \ldots$ *in* $x^a y^b z^c \ldots$, *it being understood of course that*

$$a+b+c+\ldots = \alpha+\beta+\gamma+\ldots$$

9. The finding of the said arithmetical connecting-multiplier in particular instances is, as we have seen, not at all difficult: to obtain a general expression for it, however, when the two sets of variables are n in number and their exponents are $a, b, c, \ldots$ and $\alpha, \beta, \gamma, \ldots$ is not a simple matter; and the result would in all probability be too cumbersome to invite or warrant the use of it in practice. In order that this may be more fully appreciated,—if for no other reason,—we shall take another step forward with our simple case of four variables.

10. Even here there are 35 different products, 4 of the type ω^4, 12 of the type $\omega^3\xi$, and so on; but we shall confine ourselves to one of each type, namely, to

$$\omega^4, \quad \omega^3\xi, \quad \omega^2\xi^2, \quad \omega^2\xi\eta, \quad \omega\xi\eta\zeta.$$

We have therefore first to find in each of the expansions of these the cofactors of

$$w^4, \quad w^3x, \quad w^2x^2, \quad w^2xy, \quad wxyz:$$

making in all 25 cofactors to be found and recorded. These are most conveniently representable as annexed herewith in tabular form like the elements of a square matrix.

TABLE I.

	ω^4	$\omega^3\xi$	$\omega^2\xi^2$	$\omega^2\xi\eta$	$\omega\xi\eta\zeta$
cof. of w^4 in	a_1^4	$a_1^3b_1$	$a_1^2b_1^2$	$a_1^2b_1c_1$	$a_1b_1c_1d_1$
cof. of w^4x in	$4a_1^3a_2$	$a_1^3b+3a_1^2a_2b_1$	$2(a_1^2b_1b_2+b_1^2a_1a_2)$	$a_1^2b_1c_2+a_1^2b_2c_1$ $+2a_1a_2b_1c_1$	$a_1b_1c_1d_2+a_1b_1c_2d_1$ $+a_1b_2c_1d_1+a_2b_1c_1d_1$
cof. of w^2x^2 in	$6a_1^2a_2^2$	$3(a_1^2a_2b_2+a_2^2a_1b_1)$	$a_1^2b_2+a_2^2b_1$ $+4a_1a_2b_1b_2$	$a_1^2b_2c_2+2a_1a_2b_1c_2$ $+a_2^2b_1c_1+2a_1a_2b_2c_1$	$a_1b_1c_2d_2$ $+a_1b_2c_1d_2+a_1b_2c_2d_1$ $+a_2b_1c_1d_2+a_2b_1c_2d_1$ $+a_2b_2c_1d_1$
cof. of w^2xy in	$12a_1^2a_2a_3$	$3(a_1^2a_2b_3+a_1^2a_3b_2$ $+2a_1a_2a_3b_1)$	$2(a_1^2b_2b_3+2a_1a_2b_1b_3$ $+2a_1a_3b_1b_2+a_2a_3b_1)$	$a_1^2b_2c_3+a_1^2b_3c_2$ $+2a_1a_2b_1c_3+2a_1a_2b_2c_1$ $+2a_1a_3b_1c_2+2a_1a_3b_2c_1$ $+2a_2a_3b_1c_1$	$+a_1b_1(c_2d_3+c_3d_2)$ $+a_1b_2(c_1d_3+c_3d_1)$ $+a_1b_3(c_1d_2+c_2d_1)$ $+a_2b_1(c_1d_3+c_3d_1)$ $+a_2b_3c_1d_1+a_3b_1c_1d_2$ $+a_3b_1c_2d_1+a_3b_2c_1d_1$
cof. of $wxyz$ in	$24a_1a_2a_3a_4$	$6a_1a_2a_3b_4$ $+6a_1a_2a_4b_3$ $+6a_1a_3a_4b_2$ $+6a_2a_3a_4b_1$	$4a_1a_2b_3b_4$ $+4a_1a_3b_2b_4$ $+4a_1a_4b_2b_3$ $+4a_2a_3b_1b_4$ $+4a_2a_4b_1b_3$ $+4a_3a_4b_1b_2$	$2a_1a_2(b_3c_4+b_4c_3)$ $+2a_1a_3(b_2c_4+b_4c_2)$ $+2a_1a_4(b_2c_3+b_3c_2)$ $+2a_2a_3(b_1c_4+b_4c_1)$ $+2a_2a_4(b_1c_3+b_3c_1)$ $+2a_3a_4(b_1c_2+b_2c_1)$	$+\quad\quad+$ $\lvert a_1b_2c_3d_4\rvert$

and what our theorem tell us is that the companion table giving the converse results—the cofactors of ω^4, $\omega^3\xi$, . . . in the expansions of w^4, w^3x, . . .—differs from this only in having additional an arithmetical multiplier attached to each quasi-element. The second table, therefore, is not needed in full, if we have alongside the original a dwarf table of the said multipliers only. This dwarf table turns out to be

$$\begin{array}{ccccc} 1 & 4 & 6 & 12 & 24 \\ \frac{1}{4} & 1 & \frac{3}{2} & 3 & 6 \\ \frac{1}{6} & \frac{2}{3} & 1 & 2 & 4 \\ \frac{1}{12} & \frac{1}{3} & \frac{1}{2} & 1 & 2 \\ \frac{1}{24} & \frac{1}{6} & \frac{1}{4} & \frac{1}{2} & 1, \end{array}$$

the simply interesting construction of which will be taken in at a glance. The second row is got from the first row by dividing by 4, and generally the rth row by dividing the first row by the rth element of the latter. The matrix is thus of the type known as inverso-symmetric. And as for the first row itself, its elements will be recognised from the Theory of Permutations as being

$$1, \quad \frac{4!}{3!\ 1!}, \quad \frac{4!}{2!\ 2!}, \quad \frac{4!}{2!\ 1!\ 1!}, \quad 4!$$

11. In the foregoing we have restricted the number of factors in each product to the same number as the variables. This need not be, however: and one case where it is not so, viz. where the number of variables is 2, possesses a little extra interest.

The substitutions then being

$$\left.\begin{aligned} \xi &= a_1x + a_2y \\ \eta &= b_1x + b_2y \end{aligned}\right\} \quad \text{and} \quad \begin{cases} x = a_1\xi + b_1\eta \\ y = a_2\xi + b_2\eta, \end{cases}$$

we not only readily find our first table to be

Cofactors of

	x^4	x^3y	x^2y^2	xy^3	y^4
in ξ^4	a_1^4	$4a_1^3a_2$	$6a_1^2a_2^2$	$4a_1a_2^3$	a_2^4
in $\xi^3\eta$	$a_1^3b_1$	$3a_1^2a_2b_1 + a_1^3b_2$	$3a_1a_2^2b_1 + 3a_1^2a_2b_2$	$a_2^3b_1 + 3a_1a_2^2b_2$	$a_2^3b_2$
in $\xi^2\eta^2$	$a_1^2b_1^2$	$2a_1a_2b_1^2 + 2b_1b_2a_1^2$	$a_2^2b_1^2 + 4a_1a_2b_1b_2 + a_1^2b_2^2$	$2a_2^2b_1b_2 + 2a_1a_2b_2^2$	$a_2^2b_2^2$
in $\xi\eta^3$	$a_1b_1^3$	$3a_1b_1^2b_2 + a_2b_1^3$	$3a_1b_2^2b_1 + 3a_2b_1^2b_2$	$a_1b_2^3 + 3a_2b_1b_2^2$	$a_2b_2^3$
in η^4	b_1^4	$4b_1^3b^2$	$6b_1^2b_2^2$	$4b_1b_2^3$	b_2^4

with the same usefulness as before, but we are forced to observe that the determinant of the involved matrix is identical with Schläfli's equivalent for $|\ a_1b_2\ |^{10}$.

12. From what has gone before we thus obtain a property of "the Schläflian," as the determinant has acquired sufficient importance to be called recently.* *The* r*-degreed Schläflian of any* n*- line determinant* Δ *and the like Schläflian of the conjugate of* Δ *are not only equal, but are transformable, either into the other, by operations on rows and columns*: for example, when $n=2$ and $r=r$ the transformation consists in multiplying the columns in order by the terms of the expansion of $(1+1)^r$, then dividing the rows in order by the same, and finally interchanging rows and columns.

13. When we have obtained the full expression for one of our products in terms of the other set of variables—say, the product of $\xi\eta\zeta$ in terms of x, y, z—it is natural and not altogether futile to inquire as to the effect of making in this the reverse substitution: for example, the effect of substituting in the right-hand member of the equality

$$\begin{aligned}\xi\eta\zeta = {} & a_1b_1c_1x^3 + a_2b_2c_2y^3 + a_3b_3c_3z^3 \\ & + (a_1b_1c_2 + b_1c_1a_2 + c_1a_1b_2)x^2y \\ & + (a_1b_1c_3 + b_1c_1a_3 + c_1a_1b_3)x^2y \\ & + \ldots\ldots\ldots \\ & + \overset{+}{|}\, a_1b_2c_3 \,\overset{+}{|}\, xyz\end{aligned}$$

the equivalents of x, y, z in terms of ξ, η, ζ. We feel sure, of course, that the substitution in question cannot give us in the end anything but

$$\xi\eta\zeta = \xi\eta\zeta :$$

and that when we obtain instead

$$\begin{aligned}\xi\eta\zeta = {} & \left[\sum a_1{}^4b_1c_1 + \sum a_1{}^2a_2(a_1b_1c_2 + b_1c_1a_2 + c_1a_1b_2) + \overset{+}{|}\, a_1b_2c_3 \,\overset{+}{|}\right]\xi^3 \\ & + \text{like terms in } \eta^3,\ \zeta^3,\ \xi^2\eta,\ \xi^2\zeta,\ \eta^2\zeta,\ \eta^2\xi,\ \zeta^2\xi,\ \zeta^2\eta \\ & + \text{a portentous term in } \xi\eta\zeta \text{ itself}\end{aligned}$$

there must be some striking rule of simplification that has been overlooked. In substance this rule is contained in the following theorem: *Any function of* ξ, η, ζ *given in terms of* x, y, z *can be expressed in terms of* ξ, η, ζ *by merely changing*

$$\left.\begin{matrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{matrix}\right\} \quad \textit{into} \quad \left\{\begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix}\right.$$

* By Dr. A. C. Aitken in the Proc. Edinb. Math. Soc. Another word, however, is wanted along with it to indicate the degree of its elements, it being insufficient to give only the basic determinant.

respectively. It at once suggests to us that our lengthy coefficient of ξ^3, just written, must be resolvable into the form

$$(a_1^2 + a_2^2 + a_3^2)(a_1b_1 + a_2b_2 + a_3b_3)(a_1c_1 + a_2c_2 + a_3c_3),$$

and so be equivalent to $1 \times 0 \times 0$; that the similar coefficients of η^3, ζ^3, . . ., $\zeta^2\eta$ are each reducible in the same way to 0; and that the coefficient of $\xi\eta\zeta$ is reducible to 1.

RONDEBOSCH, S. AFRICA,
6th December 1930.

A SECOND NOTE ON THE COEVANESCENCE OF PRIMARY MINORS OF AN AXISYMMETRIC DETERMINANT.

By Sir Thomas Muir, F.R.S.

1. The former note was published in 1922,* its main and concluding result being that *If an axisymmetric determinant vanish and also the sum of its primary coaxial minors, then every other primary minor must vanish also.* My present purpose is to formulate and prove another theorem on a closely related part of the subject, prefacing this, however, by a brief account of what relevant things have been done elsewhere in the interval between the two. By so doing it is hoped that here and there a chance reader may be interested in observing the blanks yet to be filled, and possibly be thus led to help things forward himself.

2. The paper of 1922 was almost immediately taken up by Nicoletti, and made the subject of a communication to the Tuscan Universities' Annals ; but, as his aim was entirely in the direction of generalization, the special properties of axisymmetrics were not contributed to. This is borne out even by the title of his paper, " Sui minori di ordine $n-2$ di un determinante di ordine n." †

3. The two next writers, B. Segre and A. Colucci, are also Italian, their subject being a statement formally made in 1908 by Dr. H. W. Richmond regarding a six-line axisymmetric determinant with nothing but zero elements in the diagonal. This was to the effect that in such a determinant we could not have five of the coaxial primary minors vanishing without the sixth vanishing also. His actual words were : ‡ " *If in a symmetrical determinant of six rows the six elements in the leading diagonal all vanish, and the five minors of these elements also vanish, the minor of the remaining element must vanish.*"

4. This result, which had been reached mainly through geometrical considerations, Segre did not question ; like the author of it, however, he was intrigued by the restriction in the order of the determinant, and set himself the task of testing it for the case of the 5th order. The outcome

* Trans. Roy. Soc. S. Afr., xi, pp. 15–18.

† Annali delle Università Toscane, xlii (1923), pp. 333–345.

‡ Proc. Cambridge Philos. Soc., xiv, pp. 475–477.

in 1925 * was an interesting proof (§§ 2, 3) that for this order it did *not* hold : and he added the simple confirmatory example

$$\begin{vmatrix} . & 16 & 1 & 1 & 4 \\ 16 & . & 1 & 1 & 4 \\ 1 & 1 & . & 1 & 1 \\ 1 & 1 & 1 & . & 1 \\ 4 & 4 & 1 & 1 & . \end{vmatrix}$$

where the values of the determinant and its coaxial primary minors are

$$-2^9\,;\ 0,\ 0,\ 0,\ 0,\ 3\cdot 2^6.$$

Further, he indicated his grounds for believing that, with the possible exception of the eighth, it did not hold for any higher order whatever.

5. Such a pronouncement was bound to attract attention, and the following year (1926) there came as a consequence Colucci's note with the significant title " Su di una presunta proprietà dei determinanti del 6° ordine." † Here by means of a simple example

$$\begin{vmatrix} . & x & . & . & . & . \\ x & . & c & b & . & . \\ . & c & . & a & . & . \\ . & b & a & . & . & . \\ . & . & . & . & . & 1 \\ . & . & . & . & 1 & . \end{vmatrix}$$

where the determinant and its coaxial primary minors have the values

$$-a^2x^2\,;\ -2abc,\ 0,\ 0,\ 0,\ 0,\ 0$$

the case for even the 6th order is overthrown. Further, a similar blow being dealt to the case of the 8th order, Segre's conclusion is considered as having been made absolute.

6. For comparison with Segre's five-line determinant, as also on its own account, I wish to draw attention in passing to the determinant

$$\begin{vmatrix} 1 & x & y & 1 & 1 \\ x & 1 & 1 & z & 1 \\ y & 1 & 1 & -1 & 1 \\ 1 & z & -1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{vmatrix}$$

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* Rendic. . . . R. Accad. dei Lincei (6), ii, pp. 539–542.

† Rendic. . . . dei Lincei (6), iii, pp. 376–377.

which differs in form from Segre's in being unit-axial but which nevertheless has

$$(-1+2x-y-z+yz)^2\,;\ 0,\ 0,\ 0,\ 0,\ (1+y)(-1+2x-y-z+yz)$$

for its own value and the values of its coaxial primary minors.

7. It may also not be amiss to recall for comparison with Richmond's " theorem " the statement that if in the determinant

$$\begin{vmatrix} . & a_1 & a_5 & a_4 & \alpha & 1 \\ a_1 & . & a_2 & a_6 & \beta & 1 \\ a_5 & a_2 & . & a_3 & \gamma & 1 \\ a_4 & a_6 & a_3 & . & \delta & 1 \\ \alpha & \beta & \gamma & \delta & . & 1 \\ 1 & 1 & 1 & 1 & 1 & . \end{vmatrix}$$

the first four coaxial primary minors vanish, then the fifth must vanish also. It was given in 1919 for proof in the Journ. Indian Math. Soc., xi, p. 200.

8. Leaving now such considerably specialized axisymmetrics, let us turn to one that is not at all specialized, namely

$$\begin{vmatrix} a & h & g & p \\ h & b & f & q \\ g & f & c & r \\ p & q & r & d \end{vmatrix},$$

and inquire what relation, if any, exists between its coaxial primary minors.*

Calling its rows r_1, r_2, r_3, r_4 and the rows of its adjugate R_1, R_2, R_3, R_4 we obtain from the products

$$R_1 \cdot r_4,\ R_1 \cdot r_3\,;\ R_2 \cdot r_4,\ R_2 \cdot r_1\,;\ R_3 \cdot r_4,\ R_3 \cdot r_2\,;\ R_4 \cdot r_1$$

the seven equations

$$\begin{aligned} pA+qH+rG+dP&=0 \\ gA+fH+cG+rP&=0 \\ pH+qB+rF+dQ&=0 \\ aH+hB+gF+pQ&=0 \\ pG+qF+rC+dR&=0 \\ hG+bF+fC+qR&=0 \\ aP+hQ+gR+pD&=0. \end{aligned}$$

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* In working with this determinant labour is saved from using the property that it is not altered on making the set of cyclic changes

$$\begin{array}{lll} a, b, c & \text{into} & b, c, a \\ f, g, h & \text{into} & g, h, f \\ p, q, r & \text{into} & q, r, p. \end{array}$$

Of necessity these involve all the elements of the adjugate, and as what we are wanting is an equation involving only four of them, namely A, B, C, D, we write the equations in the order of the eliminands P, Q, R, F, G, H, thus obtaining

$$\begin{array}{rrrrrrrrr}
d\mathrm{P} & & & & & & +r\mathrm{G} & +q\mathrm{H} & +p\mathrm{A}=0 \\
r\mathrm{P} & & & & & & +c\mathrm{G} & +f\mathrm{H} & +g\mathrm{A}=0 \\
 & d\mathrm{Q} & & +r\mathrm{F} & & & +p\mathrm{H} & +q\mathrm{B} & =0 \\
 & p\mathrm{Q} & & +g\mathrm{F} & & & +a\mathrm{H} & +h\mathrm{B} & =0 \\
 & & d\mathrm{R} & +q\mathrm{F} & +p\mathrm{G} & & & +r\mathrm{C} & =0 \\
 & & q\mathrm{R} & +b\mathrm{F} & +h\mathrm{G} & & & +f\mathrm{C} & =0 \\
a\mathrm{P} & +h\mathrm{Q} & +g\mathrm{R} & & & & & +p\mathrm{D} & =0
\end{array}$$

and thence the eliminant

$$\begin{vmatrix}
d & . & . & . & r & q & p\mathrm{A} \\
r & . & . & . & c & f & g\mathrm{A} \\
. & d & . & r & . & p & q\mathrm{B} \\
. & p & . & g & . & a & h\mathrm{B} \\
. & . & d & q & p & . & r\mathrm{C} \\
. & . & q & b & h & . & f\mathrm{C} \\
a & h & g & . & . & . & p\mathrm{D}
\end{vmatrix} = 0.$$

This in the normal non-determinant form I find, on writing

$$\alpha, \beta, \gamma \quad \text{for} \quad p^2 - ad,\ q^2 - bd,\ r^2 - cd$$

and

$$\lambda, \mu, \nu \quad \text{for} \quad qr - fd,\ rp - gd,\ pq - hd,$$

to be

$$\begin{aligned}
&\{a\alpha\beta(cp - gr) + g\alpha\mu(qh - bp) + a\mu\nu(pf - gq) + h\mu\nu(ar - pg)\}\mathrm{A} \\
&+\{h\beta\gamma(aq - hp) + a\beta\nu(rf - cq) + h\nu\lambda(qg - hr) + g\nu\lambda(bq - qh)\}\ \mathrm{B} \\
&+\{g\gamma\alpha(br - fq) + h\gamma\lambda(pg - ar) + g\lambda\mu(rh - fp) + a\lambda\mu(cq - rf)\}\ \mathrm{C} \\
&\qquad + p(\alpha\beta\gamma + \lambda\mu\nu)\mathrm{D} = 0,
\end{aligned}$$

where the binomials $cp - gr$, . . . are like α, β, γ, λ, μ, ν two-line minors of the basic determinant.

9. According to this, If the general axisymmetric of § 8 be such that its first three coaxial primary minors A, B, C vanish, we cannot assert that its fourth D must vanish also, but merely that

$$(\alpha\beta\gamma + \lambda\mu\nu)\mathrm{D} = 0.$$

10. For the case where the diagonal elements are zeros the values of the determinant and its coaxial primary minors are

$$(fp - gq + hr)^2 - 4hfrp\ ;\ 2frq,\ 2gpr,\ 2hqp,\ 2fgh :$$

whence we see readily what further specialization will entail the vanishing of the second, third, and fourth without having the like effect upon the first and fifth.*

RONDEBOSCH, S. AFRICA,
27th January 1931.

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* Since the above was written I learn that a paper dealing with closely related matters was presented by L. M. Blumenthal to the Amer. Math. Soc. on 16th June 1931 and was printed in the October number of the Bulletin.

THE COMPOSITION OF THE DEEPER SEDIMENTS OF THE PIPE AT BANKE, NAMAQUALAND, AND THEIR RELATION TO KIMBERLITE.

By E. Reuning, Cape Town.

Introduction.

In a paper on the geology and palaeontology of the western edge of the Bushmanland plateau I have examined the relation of the Tertiary beds and Surface Quartzite to the Dwyka and the Kimberlite occurrences.* At that time I had to leave untouched the question of the origin of the deep sediments of the Banke pipe (described as kieselguhr), because it was not possible to make analyses and microscopic studies of these sediments. The results obtained in a new work by F. Kirchheimer (see this volume, pp. 41–50) have caused me to undertake this present investigation.

The beds rich in bitumen and coaly substance which underlie the white calcareous clay at a depth of 50 feet (see these Transactions, vol. xix, p. 228, Profile) pass gradually into a sediment which, from its external appearances, was described as kieselguhr. This description must be corrected, since the microscopic study has not shown the undoubted presence of diatoms. Nevertheless, lowly organisms, algae, etc., are present, and the sediment can better be described as dysodil.†

I. Microscopic Investigation of Dysodil.

The dysodil appears under the microscope as a very fine-grained sediment showing clear bedding owing to the parallel-lying vegetable, coaly substances and to the variations in calcareous content.

The mineral grains of which it is built up have a diameter of about 5–10 μ; the largest mineral grain found in nine thin sections only reached $\frac{1}{2}$ mm. Nevertheless, there occur occasionally in association with organic substances—possible excrementa—accumulations of larger grains, of ilmenite, garnet, phlogopite, and more sparingly of felspar and quartz, of an average diameter of 1–2 mm.

Slightly rounded single grains of quartz or felspar of 10–12 mm. in size

* E. Reuning, Trans. Roy. Soc. S. Afr., xix, pt. 3, 1931, pp. 215–232.

† Dr. A. W. Rogers has also pointed out to me in a letter of 20/9/1931 the absence of any diatoms. See further F. Kirchheimer, this volume, p. 41.

are very exceptional. Such lie irregularly in fine-grained sediment and may have been carried in by the agency of roots.

The main body of dysodil lying below the bituminous clay horizon (51–58 feet) consists of a yellowish to yellowish-green almost uniform ground-mass, which carries a very great number of elongate organic substances, greenish serpentine-like rounded rods, high-refracting filamentous blades, and very minute mineral grains.

Under higher magnification the ground-mass is differentiated into a maze of the finest, reedy, needle-like flakes and rods of serpentine material. In the layers rich in lime these are subordinate to, or are wholly replaced by, a fine-grained calcite-dolomite aggregate.

In the ground-mass lie elongate, bent filaments and stems of a coaly substance, varying in length from a few μ to some centimetres. In addition to these organic remains there are very many varying structures, circular and oval in section, as well as elongate and articulated forms, that must belong to lowly forms of life. F. Kirchheimer has identified the pollen-content (see p. 43).

The mineral particles that are so common in the ground-mass cannot, because of their minute size, be identified with certainty. A more or less strongly altered phlogopite is comparatively frequent. In certain thin beds it forms up to one-third of the volume, being absent altogether in neighbouring layers. It is recognisable by its filamentous structure and the high double-refraction that is often present.

Blue-black, sometimes granular-looking, particles and small opaque grains indicate ore-materials. The larger grains appear to be ilmenite; they are often altered and enveloped in a leucoxene-like mass. The fine-grained ore-pigment is probably limonite.

The remaining mineral grains are much fewer in number than those mentioned. A little garnet, a little perofskite, isolated representatives of the hornblende and augite groups, and, much more rarely, felspar and quartz granules, were all recognised.

II. The Opal Deposits and Pyrite Concretions.

In the middle and lower horizons disclosed in the main shaft there are numerous masses of opal and concretions with pyrite.

Lens-like tubercles of about $\frac{1}{2}$ to 2 cm. in size, kidney-shaped aggregates, flat cakes and nodules as big as a fist, lie embedded in dysodil. Certain beds are particularly rich in these. Masses of opal impregnated with granules of pyrite are common; in the nodules these are in streaks, but in the separate opal lenses they are aggregated in the border zone.

In the isotropic masses of opal are found much calcareous material and

rounded and oval cross-sections of fossil organisms; the mineral grains that were mentioned as occurring in the dysodil are almost absent.

Occasionally, portions of the opal begin to show low interference colours between crossed Nicols. Sometimes it is possible to determine the beginning of alteration by the presence of chalcedony.

The pyrite forms a granular cement in the stalked, flattened, lens-like and plate-like concretions; it is also found as a network penetrating the dysodil, and as rosettes.

In polished section it is not possible to determine the presence of marcasite.

Both opal and pyrite are of epigenetic origin; yet their formation must have followed relatively close upon the deposition of the sediments.

III. The Chemical Composition of the Dysodil.

The extraordinarily small part that grains of quartz play in the composition of the dysodil, which is borne out by the microscopic evidence—which, on account of the wide distribution of granite around the Arnot pipe, would not have been expected—permits of the suspicion that the origin of the dysodil is bound up with the content of the pipe.

From hand-specimens taken from various horizons from 70–107 feet in depth, a composite sectional specimen was formed; of this Dr. L. Möser of Giessen has made a complete analysis. The results are shown in the table, p. 36, together with the molecular ratios and the Niggli-values.

According to my investigations * a kimberlite province occurs in that portion of Bushmanland. On Boschjeslaagte, only 3½ miles E.N.E. of the Arnot pipe at Banke, kimberlite was found below 40 feet of sandstone and clay. All the evidence points to the presence of kimberlite below the clays and dysodil at Arnot also. The possibility that the depths of the pipe were filled with melilite-basalt cannot be completely discarded, but is highly unlikely. In order to compare the relationships of the dysodil to kimberlite and to melilite-basalt, the Niggli-values of 10 and 4 analyses respectively of these two rock-groups have been calculated and the values of dysodil set alongside them.

The chemical composition of the dysodil compared with that of the various rocks found in the neighbourhood of the Arnot pipe—granite, Karroo sediments, Karroo dolerite, melilite-basalt, and kimberlite—shows clearly that the denudation products of the first two named can only have contributed in a very minor degree to the material of the dysodil, if at all; otherwise much higher *si*, *qz*, *al* and *alk* figures would have been expected. Similarly there can be no question of a doleritic contribution.

* E. Reuning, *loc. cit.*, pp. 215–232.

When the Niggli-values of the dysodil are compared with those of melilite-basalt and kimberlite, the following striking similarities are seen: *si* and *qz* completely corresponding; *al, fm, c* and *alk* of the dysodil intermediate between those relating to melilite-basalt and kimberlite; likewise *mg* and *c/fm*.

	Weight per cent.	Molecular ratios $\times 10^4$.		Niggli-values. Dysodil Banke.	Average 10 kimlites S.A.	Average 4 melilite-basalts S.A.	Total aver. kimb. and mel.-bas.
SiO_2	27·28	4524	*si*	69·1	54·6	64·9	59·7
Al_2O_3	5·24	513	*qz*	− 40·3	− 52·2	− 63·4	− 57·8
Fe_2O_3	3·18	199	*al*	7·8	2·5	11·9	7·2
FeO	3·67	511	*fm*	62·2	84·9	52·9	68·9
MnO	0·28	39	*c*	26·9	10·8	28·1	19·5
MgO	12·58	3120	*alk*	3·1	1·8	7·1	4·4
CaO	9·86	1758	*k*	0·16	0·68	0·29	0·48
Na_2O	1·07	173	$\frac{alk}{al}$	0·40	0·71	0·66	0·68
K_2O	0·30	32	*mg*	0·77	0·87	0·66	0·77
H_2O+	4·95	2748	$\frac{c}{fm}$	0·43	0·21	0·55	0·38
H_2O-	7·57	4202	*ti*	1·4	2·0	3·3	2·7
CO_2	21·08	4790	*p*	0·4	0·8	0·6	0·7
SO_3	0·05	3	co_2	73·2	7·0	..	..
TiO_2	0·72	90	*h*	106·3	48·2	11·4	..
P_2O_5	0·35	25	..	..	..	..	..
Carb. matter	1·77	1475 as carbon	..	..	..	..	..
	99·95						

There are, nevertheless, differences present. Of the alkalies, whose totals occupy an intermediate position, one—*k*—is substantially lower than *k* in the two basic eruptive rocks. During the very considerable alteration and weathering which kimberlite undergoes in the course of even a few years—in this connection one recalls the old method of preparation of blue ground—the alkalies must, for the greater part, pass into solution. The original small quantity of potassium must partly be dissolved, and partly used up by vegetation. Lime and magnesia, mostly in combination with CO_2, have undergone only a small amount of destruction and transportation; the same applies also to the phosphoric acid.

The lower titanium content is easy to explain. Although the ilmenite in the dysodil has apparently remained unaffected, the total quantity present is somewhat lower than in the two groups of basic rocks. This can be explained on the supposition that at the time when the substances forming the dysodil were washed into the pipe, the heavy insoluble larger grains of ilmenite remained behind. Nevertheless, in a later cycle, the ilmenite grains were transported into the depression, together with the denudation products of the granite, as is evidenced by the superficial clayey sediments, and they also take part in the formation of the ilmenite-bearing sandstones and conglomerates that, at the present time, border the southern edge of the pipe.

IV. Discussion of Results.

From the results of the microscopic investigation and the chemical composition of the dysodil, it can be concluded with the greatest probability that its material was formed from a kimberlitic rock. Although the Niggli-values of the dysodil are intermediate between those of melilite-basalt and kimberlite, the former scarcely comes into the question. One must consider in this connection a trifling transposition of material brought about by solution, and still continuing, in view of the fact that the pipe—which is entirely within granite—has continually had a variable rising and falling water-level; just as, at the present time, the water-level varies according to the annual and periodic rainfall conditions. The water that was found at a depth of 45 feet in 1930 was strongly alkaline and rich in sulphate of magnesia. It can be concluded, therefore, that—in addition to alkalies—magnesium salts have been carried away, and that formerly the MgO had a higher value than the analysis now shows.

The question now arises whether the dysodil originated and was deposited *in situ* or was transported, wholly or in part, into the pipe from outside.

Nearly all kimberlitic rocks contain xenoliths from the surrounding rocks and from the superficial deposits present at the time of eruption, particularly of Karroo sediments. The kimberlites of Boschjeslaagte and of Papkuilsfontein (see Map, vol. xix of these Transactions, p. 217) are loaded with inclusions of granite and gneiss to such an extent that it is difficult to obtain a piece of pure kimberlite, even of the size of a nut. The proportion of inclusions from neighbouring rocks in the whole of the pipe-material is 1/10 to 1/5. Had the formation of the dysodil been *in situ*, the granitic portion would have been strongly apparent; but neither chemically nor microscopically does it appear in the slightest degree. Above all, there is an absence of the larger ilmenite grains—which are richly

present in the kimberlite of the neighbouring pipes—and of the larger grains of garnet and diopside. The almost complete absence of derivatives of granite, and the presence only in the finest particles of ilmenite, garnet, etc., yield undoubted evidence for the washing-in of the material. Moreover, at that period the granitic foundation of the neighbourhood of the pipe must certainly have been covered completely by deeply decomposed ejected kimberlitic material, whose finest portions, through the action of water, reached the depression which had been caused by a prolonged sagging of the material filling the pipe. The large amount of slickensiding of the kimberlite at Boschjeslaagte and other places shows that there was a movement of the already serpentinised and altered kimberlite. This may have been caused by a sinking of the general water-table and a consequent crumpling of the decomposed kimberlite.

This explanation of the origin of the dysodil is obvious, particularly when the present-day local relationships are examined and conclusions drawn from the geologic past.

The whole mass of dysodil enclosed in the pipe must have been deposited before the exposure of the granite ; otherwise granitic material must have been found in the upper layers.

We obtain, accordingly, a clear proof of the fact that ejected kimberlitic material occurred around the pipe in considerable masses, and that from it only the finest mud was deposited in the depression formed during the crumpling of the rock filling the vent. This conjecture, already suggested in my former paper (vol. xix, p. 231), receives, therefore, substantial support.

Accepting the correctness of these assumptions, we arrive at the following far-reaching conclusions :—It is a well-known fact that, in all the kimberlite mines that have been worked, the percentage of diamonds present, without exception, decreases with depth. Consequently, we must assume that the portion of the kimberlite mass from the pipe which has been lost by denudation—some hundreds of metres in thickness—was rich in diamonds, and also that the ejected material that lay around the pipe carried diamonds. These masses were subjected to a very rapid weathering —one can refer in this connection to the earlier methods of working the blue ground. During the period following the kimberlite eruption, a period that was certainly one of considerable denudation, the extruded masses suffered a rapid natural pulverisation, and the products of this were transported elsewhere. For this reason, a vast amount of the more resistant constituents of the kimberlite must, at that time, have reached the headwaters of the then river-systems. Whilst all the other minerals were completely destroyed, the diamonds were carried in great quantities into the river deposits and down to the bed-rock of the rivers, where at the present day they are found in terraces that are often rich.

Above all, on the coasts of South and South-West Africa the earliest occurrences of diamonds always show a high concentration. The succeeding younger beds of the same kind and of the same cycle are always poorer in diamonds, except when there has been a local removal and reconcentration.

This fact, hitherto inexplicable, finds a simple solution in the proportionately rapid disintegration of the erupted kimberlite and in the speedy transport of the diamonds into the river deposits and sea.

On the basis of the nature and chemical composition of the dysodil of Banke, it can be concluded with great probability that the kimberlite occurred in the form of a strato-volcano, and that the diamonds that are found in the oldest diamondiferous sediments in such a high degree of concentration were chiefly contained in the erupted masses.

ON POLLEN FROM THE UPPER CRETACEOUS DYSODIL OF BANKE, NAMAQUALAND (SOUTH AFRICA).

By F. Kirchheimer, Giessen.

(With Plates V and VI, and six Text-figures.)

From the sediments filling the " Arnot " Pipe on the Bushmanland plateau in Namaqualand, Reuning collected numerous remains of frogs, which were investigated and described by Haughton (1931, p. 233).* Together with these were found plant-remains, mostly of a fragmentary character, whose investigation by Rennie (1931, p. 251) helps to extend, in a small measure, our former very insufficient knowledge of the fossil Angiosperm flora of South Africa.

Upon the geological position, the stratigraphical relations, and the petrographical nature of the occurrence, Reuning (1931, p. 227) has given an account to which further reference will be made in the sequel. It is necessary, at the start, to point out that the so-called " Kieselguhr " of Banke is not a fossiliferous deposit containing primarily an accumulation of tests of various Bacillariaceae (Diatoms).† Completely similar in external properties, the analysis of its organic micro-components—particularly those belonging to the plant kingdom—shows it to be a dysodil, although its bitumen content for the most part is not important. Finally, it is important to point out that the occurrence is pre-Tertiary, and, indeed, probably Upper Cretaceous. Although the fossil evidence on this point is not absolute, at least the stratigraphy supports the age assigned.

Prof. Dr. Hummel of Giessen gave me a specimen of dysodil from the locality mentioned, and asked me to search for a possible pollen-content. Prof. Dr. Reuning of Giessen furnished me with further material as a result of my first investigation, and, in a most friendly manner, furnished information concerning certain questions which had arisen during the course of the investigation. To both these gentlemen thanks are due for the appearance of the present article.

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* Reference to the works cited follows at the end of this paper.

† In spite of the examination of a large number of specimens, Bacillariaceae were not found. This is not of necessity proof of their original absence, for the tests of these algae in rocks appear to possess no absolute powers of resistance against the varied chemical agents of solution (see Pia, 1931, p. 125). It is noteworthy that Bacillariaceae do not occur in the opalised masses that are embedded in the dysodil.

METHOD.

The richest pollen-content occurs in a dysodil from about 100 feet down in the " Main Shaft " in the middle of the " Arnot " pipe (see REUNING 1931, p. 228). This is a very light, light-grey, well-bedded rock, that contains, besides a large number of frog-remains, dicotyledonous leaves and other parts of plants. Under the microscope it shows a few figured plant-remains, together with wood-fragments and amorphous humus-material, set in a siliceous ground-mass. Fragments of epidermis and cuticle as well as spores and pollen-grains are worthy of note. Bedding is visible owing to the varying richness of the layers in humus-material and microscopic plant components (see Pl. V, fig. 1). Many specimens yield a high percentage ot lime, which probably favours the preservation of the batrachian bones. This has contributed in large part to the formation of the opal mentioned (see below).

Dysodil.—Since the pollen-content everywhere is small, it is necessary to use for the concentration of the pollen a special method of preparation, which has already been used many times in other investigations. From the inner part of the hand-specimens portions of about ½ c.c. were taken. All vessels, instruments, etc. which were to come into contact with these, or their derivatives after preparation, were treated with fuming nitric acid (sp. gr. 1·54) in order to destroy any recent pollen that might be attached to them. Since the investigation was carried out in the autumn, further cauterisation to prevent contamination by pollen produced from vegetation in the neighbourhood of the laboratory was unnecessary.

After pulverisation to a grain-size of 2 mm. and subsequent decalcification, the individual specimens were each placed in a closed porcelain crucible coated with paraffin wax and treated with cold dilute hydrofluoric acid for about 12 hours. After decanting the extract, the silica-free residue was repeatedly washed with distilled water, allowed to settle, decanted and rewashed. When examination showed that the pollen was sufficiently transparent, the treatment was discontinued.

Opal Concretions.—These occur in great number and variety of forms (see REUNING, 1931, p. 228). Each contains abundant quartz gels, partly opalised, attached to vegetable micro-components (wood-fragments, cuticles, spores, pollen, etc.). These gels are preponderatingly nodular in shape, and may be pyritised, especially in the outer parts. Many of them possess a rind rich in carbonate, similar to those which KLÄHN (1929, p. 276) has described from a siliceous formation of a Miocene fresh-water dolomite of the Vogelsberg. Stratification such as occurs in the dysodil is completely lacking, as far as our observations go, although in thin section tiny shrinkage cracks can be seen. For the investigation polished slices, etched slices, and thin sections were used (see Pl. V, fig. 2).*

* It is not possible here to enter into the question of their origin. The mode of occurrence appears to favour a later concretionary origin and not a syngenetic one.

The pollen-content of the opal nodules, in its general nature, agrees with that of the dysodil, but is in a much better state of preservation. It can be accepted that the impregnation of the extine (exine) by the opal-material protects them greatly against later alteration. Many individuals even appear with their shapes completely preserved (see Pl. V, fig. 3B and 4B) owing to the infilling of the cell by colloidal silicic acid. The importance of this in the preservation of fossil pollen has already been pointed out (see KIRCHHEIMER, 1930, p. 456).

The text-figures are taken from tinted positives, claiming to be true to Nature, and serve to explain the original photographs of the plates. These were taken with a tested LEITZ-lens (Oc. 10x and 20x; Obj. 3, 7*a* and 1/12*a*), using highly sensitive PERUTZ panchromatic plates, and show the pollen in a particularly recognisable manner. The figures are printed from untouched negatives.

I.

The Pollen-content.

General Remarks.—The relative enrichment of the pollen-content as a result of the desilicification of the samples is considerable. Thus in the sections of the prepared material (18 × 18 mm.) there were, on an average, eight extines preserved, apart from very many fragments which were not of morphologic value.

The occurrence of these shows that the mode of preservation of the pollen is not good, being much worse than in most German lignites. Numerous extines are strongly deformed, to an extent that makes them almost unrecognisable; corroded and disorganised individuals (see KIRCHHEIMER, 1931*a*, p. 128) number about 25 per cent. of the pollen-content. The injuries to these are probably primary (see KIRCHHEIMER, 1931*b*, p. 789), since in the preparation of the matrix pollen-destroying agencies (weak alkalies, oxides) were not employed. The necessary facts concerning the pollen of the opaline bodies have already been stated.

The manner in which the forms are described follows a classification scheme which has been briefly proposed elsewhere (KIRCHHEIMER, 1931*c*, p. 77). Nevertheless, no inventory of the beds investigated will be attempted; only those types will be discussed whose pollen-nature and distinctive properties are fully apparent.

Isolated single pollen-grains.

1. Extines without germ-pores or localised germ-exits (Austrittstellen).
   (*a*) Smooth or only slightly decorated;
   (*b*) Clearly decorated.

Such forms are found in considerable numbers. Nevertheless they cannot be identified as pollen with certainty, as spores belonging to various groups develop similar membranes. Some fungal conidia, which are found both in the polished sections and in the treated preparations, can be identified with certainty. Tetrahedral-globular spores with three basal edges belong to the Pteridophytes, although no closer identification is possible.

The pollen-nature of the following types is, on the other hand, undoubted, because of the existence of varying forms of localised germ-exits in the extine.

TEXT-FIG. 1.
Polar view (×650).

TEXT-FIG. 2.
Polar view (×650).

2. Extines with germ-pores or localised germ-exits.

(*a*) Rounded germ-exits or free germ-pores.

Plate VI, figs. 1, 2 ; Text-fig. 1.

Pollen round-triangular in polar view, elliptical in side view, average size 25 (22–27) μ *; the extine is smooth and carries three equatorial, usually equidistant germ-pores with weakly protuberant, club-like thickened edges.* This form is very common, but mostly in a corroded state of preservation.

Plate VI, fig. 3 ; Text-fig. 2.

Pollen definitely triangular in polar view, elongate-elliptical (?) in lateral view, average size 30 (27–32) μ *; the extine is covered with a fine network with rounded mesh, and has three equatorial, equidistant, feebly protuberant germ-pores.* This form is found infrequently.

Plate VI, figs. 4, 5 ; Text-fig. 3.

Pollen rounded in polar view, elongate-elliptical in lateral view, average size 23 (20–25) μ *; the extine is thin, smooth, with three equatorial, equidistant germ-exits, that appear to be somewhat drawn-out and fold-like in the long axis of the grain.* This form occurs frequently, but often in a considerably deformed or corroded state (fig. 5).

(*b*) Fold-like germ-exits or germ-pores lying in grooves (Faltenpollen).

Plate V, figs. 4A, 4B ; Plate VI, figs. 6, 7 ; Text-fig. 4.

Pollen trilobed in polar view, elliptical in side view, average size 21 (17–26) μ *; the extine is moderately strong, granulated, with three deep parallel equidistant longitudinal grooves, in the middle of each of which is a germ-pore.* This pollen type, which is rich in variety of forms, occurs in great number. The individuals show many injuries, among which splitting along the grooves is particularly noticeable (fig. 7).

TEXT-FIG. 3.
Polar view (×650).

TEXT-FIG. 4.
Polar view (×650).

TEXT-FIG. 5.
Lateral view (×650).

TEXT-FIG. 6.
Dorsal view (×650).

3. Extines expanded into wings (Winged-pollen).

Plate V, figs. 3A, 3B ; Plate VI, fig. 8 ; Text-fig. 5.

Pollen, measured with wings, of average size 35 (32–39) μ *; body elongate ellipsoid, wings clearly demarcated, hemispherical, the diameter of each about half that of the body ; in the neighbourhood of the wing-insertion the extine of the pollen body is similarly faintly meshed, but elsewhere smooth ; crest absent.* This pollen occurs sparingly, and is found mostly corroded and disorganised.

Plate VI, fig. 9 ; Text-fig. 6.

Pollen, with wings, of average size 53 (48–57) μ *; body apparently reduced, wings clearly demarcated, each about as large as the body, flattened-spherical ; extine of pollen body entirely smooth, wing-surface weakly reticulate, dorsally and ventrally embracing the body by a large and crest-like formation.* This form is very rare and occurs mostly in a very disorganised condition.

Special Remarks.—Before these facts are evaluated it is necessary to prove the fossil nature of the pollen. Since the preparation of the material was carried out with every precaution against contamination, it is probable that the investigation was made on pollen that was definitely contained in the rock-specimens. This probability is raised to certainty by the similarity of the pollen-content of the dysodil to that of the opal nodules, since these latter can scarcely have suffered a later addition of pollen. On the other hand, an introduction of material into the rock at the site, by means of wind and the capillary action of surface water, is not unthinkable. In this manner, *e.g.*, recent Bacillariaceae have been introduced into Carboniferous coals (see PIA, 1931, p. 121).

Nevertheless, the poverty of the vegetation of the immediate vicinity and surrounding area of the place of origin helps to increase the improbability of such an idea. Moreover, the distribution of the pollen in the shaft-section does not favour a theory of secondary pollen enrichment from without. The highest pollen frequency is in the lower beds, which show a decrease in the number of cracks and joints, a fact that cannot be reconciled with the downward movement of recent pollen into the rocks. Moreover, the pollen-bearing dysodil from about 60 feet depth is covered with thick clay-beds with sandy and calcareous intercalations (see REUNING, 1931, p. 228), which would act as a barrier against the movement of recent pollen.

Finally, various facts are in favour of the described forms being true pollen-grains and not appearances due to some other organic or inorganic agent. Apart from the typical membrane structure, and the positive result obtained from the absence of any specific microchemical reaction (see KIRCHHEIMER, 1931*b*, p. 790), the morphological relations to recent forms of pollen appear to be important. As has already been shown, the fossil objects can without difficulty be fitted into the typologic scheme prepared for Recent and Tertiary pollen. The following forms can even be attached to pollen-forms of definite systematic position :—

Plate VI, figs. 1, 2 ; Text-fig. 1.—This pollen is of betulacean type, which incidentally is found in a remarkable manner in many July-flowering families. Noticeable is the close similarity to *Corylus* TOURNEF. and *Myrica* L.

Plate V, figs. 4A, 4B ; Plate VI, figs. 6, 7 ; Text-fig. 4.—In general form this agrees with pollen of a large number of genera of very varied systematic position. The form is distinguished from the tri-lobed pollen of *Mesembryanthemum* L. by its deep grooves with the embedded germ-pores.

Plate V, figs. 3A, 3B ; Plate VI, fig. 8 ; Text-fig. 5.—Pollen similar to this occurs only, as far as our knowledge of pollen morphology goes, among the Abietinae (other than *Larix* MILL. and *Tsuga* CARR.).

Plate VI, fig. 9; Text-fig. 6.—This is doubtless a conifer pollen. It is unlikely to belong to the Abietinae. Lacking a good supply of recent material for comparison, it is not possible to place it in *Podocarpus* L'HER. or in one of the neighbouring genera with winged pollen.

The remaining forms also have present-day analogues, but their pollen-nature cannot be so clearly demonstrated as in the case of the specified types.

II.

Discussion.

Among the plant-fossils of the pollen-bearing beds RENNIE (1931, p. 251) was able to determine only *Myrica* (which was dominant); other fragments (among them a portion of a fern frond) could not be accurately interpreted.* The pollen-content shows the frequent occurrence of four Angiosperms (all Dicotyledons) and two Conifers; isolated individuals supplement the occurrence of the fern frond; and other spores also occur. The exact botanical identification of the pollen and consequently of their plant-species is, for the time being, impossible. The difficulty is even greater here than that which has up to the present hindered in a large degree the evaluation of the pollen of the Tertiary Lignites of Germany (see KIRCHHEIMER, 1931*c*, p. 75).

Important is the discovery that none of the pollen types can be correlated with the known present-day flora of the area belonging to genera of the Aizoaceae, Büttneriaceae, Euphorbiaceae, Proteaceae, Mimosaceae, Ebenaceae, Scrophulariaceae, Acanthaceae, Compositae, and Liliaceae. One pollen (Pl. VI, figs. 1, 2; text-fig. 1) is coryloid, and, in view of the convergence *Corylus-Myrica*,† can with difficulty be distinguished from the pollen-grains of the latter genus, which occurs at the present day in South Africa (Cape Province). This fact appears remarkable, particularly in view of the numerous leaf-remains of *Myrica* in the deposit. Pollen of the European *Myrica gale* L., according to several authors (see FIRBAS, 1929, p. 397), cannot be preserved; but no investigations have yet been undertaken on the powers of resistance of the pollen of the South African species (*Myrica aethiopica* L., etc.).

* In a verbal communication, Prof. Dr. REUNING informs me that among the leaf-fragments from the shaft a small amount of cuticle was obtained. An analysis of this cuticle was not, unfortunately, undertaken.

The opalised wood-remains of *Ficus* (ADAMSON, 1931, p. 255) came from the overlying, substantially later beds of the occurrence (Opal sandstone), according to a statement by HAUGHTON (1931, p. 233) confirmed to me by REUNING.

† It is a question whether the small morphological differences between the pollen of these two genera, as indicated by JENTYS-SZAFER (1928, p. 88), can be utilised in the case of highly fossilised material.

One of the two winged-pollen types belongs certainly to the Abietinae, as already stated. It differs from those Recent species of *Pinus* L., *Picea* A. DIETRICH, and *Abies* L., whose pollen-morphology is known, in spite of its pinoid character, by its very much smaller size. The small amount of conifer pollen compared with that of the Angiosperms is remarkable; the ratio established by counting is 1 : 9. In view of the rich production of pollen, widely distributed by wind, by conifers, this discovery leads to the conclusion that the flora of the neighbourhood at the time of formation of the dysodil was predominantly angiospermous and that conifers were only to be found at a considerable distance away.

If we accept an Upper Cretaceous age for the deposit, the existence of the Angiosperm pollen becomes of general importance. Although a large number of Angiosperm-remains are known in Cretaceous beds from the Gault onwards, knowledge of their pollen has been wholly lacking until now. On the basis of the facts cited, it follows that the pollen of Cretaceous Angiosperms was morphologically close to that of present-day types which were already developed in the Tertiary, since in many cases the places predestined for the exit of germ-tubes (germ-pores, localised germ-exits, grooves) were distributed in similar manner. Pollen with similar, mostly thinner, extines were present*; on the other hand, forms with extremely differentiated membranes (spiny pollen, etc.; see FISCHER, 1890, p. 48) were not present among the pollen examined. Thus there were no pollen of the Compositae, which to-day are found in the area in the form of shrubs. Neither ericoid pollen-tetrads nor pollinia (such as those of *Acacia* WILLD., which lives in the area) were found. The present-day Ericaceae find their fullest development (about three-quarters of the known species) in South Africa (Cape Province); ericoid pollen-tetrads are found in the Middle Eocene Lignite of Germany (see KIRCHHEIMER, 1931*c*, p. 83). Consideration of the very enticing morphogenetic evaluation of the occurrence will be postponed until the submission of the results of further work.

Summary.

Pollen forms, belonging to Conifers and Angiosperms, are described from a dysodil, probably of Upper Cretaceous age, from Namaqualand (South Africa). Although they do not permit of exact morphologic comparison with the pollen of Recent plants, there is, at present, no doubt as to their close affinity. They do not in the least agree with the present-day flora of the area. This serves to show, in conjunction with the

* See p. 44. Similar pollen is possessed by many Gymnosperms, particularly Conifers.

character of the megascopic plant remains, that the ecological character of the area at the time of formation of the deposits was widely different from that of to-day.

List of Literature.

ADAMSON, 1931 : " Note on some Petrified Wood from Banke, Namaqualand," Trans. Roy. Soc. S. Afr., **19**, pt. iii (1931).

FIRBAS, 1929 : " Einige Bemerkungen zur heutigen Anwendung der Pollen-analyse," Centralbl. f. Min., etc., Jahrg. 1929, Hft. 9 (1929).

FISCHER, 1890 : " Beiträge sur vergleichenden Morphologie der Pollenkörner," Dissertation, Breslau (1890).

HAUGHTON, 1931 : " On a Collection of Fossil Frogs from Banke," Trans. Roy. Soc. S. Afr., **19**, pt. iii (1931).

JENTYS-SZAFER, 1928 : " La structure des membranes du pollen de *Corylus*, de *Myrica* et des espèces européennes de *Betula* et leur determination à l'état fossile," Bull. Intern. Acad. Pol. Sc. et Lettr., ii (1928).

KIRCHHEIMER, 1930 : " Braunkohlenforschung und Pollenanalytik," Braunkohle, **29**, Hft. 21 (1930).

———— 1931*a* : " Zur pollenanalytischen Braunkohlenforschung I," Braunkohle, **30**, Hft. 7 (1931).

———— 1931*b* : " Zur pollenanalytischen Braunkohlenforschung II," Braunkohle, **30**, Hft. 36 (1931).

———— 1931*c* : " Ein Beitrag zur Kenntnis von Pollenformen der Eozänbraunkohle des Geiseltales," Die Wirbeltierfundst. des Geiseltales, herausgegeb. von d. Kais. Leopoldin. Deutsch. Akad. der Naturf. Halle, 1931.

KLÄHN, 1929 : " Die Genese lakustrer Dolomite und Kiesel-ausscheidungen (Fall Garbenteich), etc.," Neues Jahrb. f. Min., etc., B, **61** (1929).

PIA, 1931 : " Vorliassische Diatomeen ? (Sammelreferat)," Neues Jahrb. f. Min., etc., Ref. 1931, iii, Hft. 1 (1931).

RENNIE, 1931 : " Note on Fossil Leaves from the Banke Clays," Trans. Roy. Soc. S. Afr., **19**, pt. iii (1931).

REUNING, 1931 : " A Contribution to the Geology and Palaeontology of the Western Edge of the Bushmanland Plateau," Trans. Roy. Soc. S. Afr., **19**, pt. iii (1931).

Geologisch-Palaeontologisches Institut der Universität Giessen, im Oktober 1931.

Explanation of Plates.

PLATE V.

FIG. 1.—Dysodil from Banke (thin section, transverse), junction of two layers visible in the hand-specimen. The darker layer is characterised by the greater proportion of plant fragments ; the lighter contains more of the siliceous ground-mass. × 100.

FIG. 2.—Opal nodule from Banke (longitudinal section). Corroded pyrite crystals, humus material and figured plant-remains are visible, in a light siliceous ground-mass. × 100.

FIG. 3A.—Dorsal view of a winged pollen (see p. 45) from an opal nodule from Banke (longitudinal section). × 350.

FIG. 3B.—The same, × 1000.

FIG. 4A.—Polar view of a grooved pollen (see p. 45) from an opal nodule from Banke (cross-section). ×350.

FIG. 4B.—The same, ×1000.

PLATE VI.

FIGS. 1 and 2.—Polar view, see p. 44 (dysodil from Banke, prepared mount). ×350.

FIG. 3.—Polar view, see p. 44 (dysodil from Banke, prepared mount). ×350.

FIG. 4.—Polar view, see p. 44 (dysodil from Banke, prepared mount). ×350.

FIG. 5.—The same, somewhat corroded.

FIG. 6.—Grooved pollen (optical cross-section), see p. 45 (dysodil from Banke, prepared mount). ×350.

FIG. 7.—The same (high position), torn open along the groove.

FIG. 8.—Winged pollen (lateral view, see p. 45), showing beginning of corrosion and disorganisation of the wing (dysodil from Banke, prepared mount). ×350.

FIG. 9.—Winged pollen (lateral view, see p. 45), showing beginning of corrosion (dysodil from Banke, prepared mount). ×350.

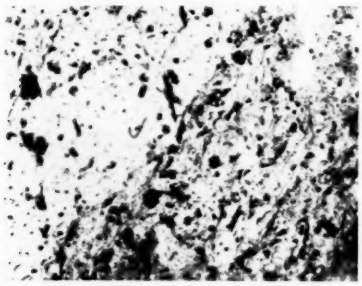

FIG. 1.

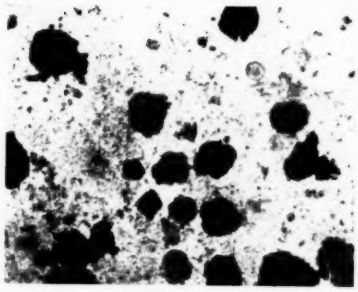

FIG. 2.

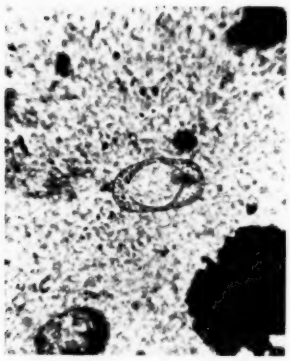

FIG. 3A.

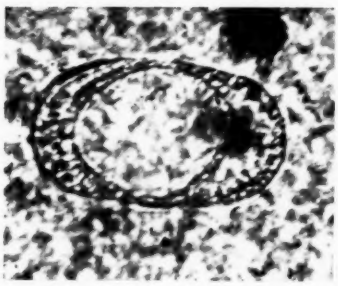

FIG. 3B.

FIG. 4A.

FIG. 4B

F. Kirchheimer, photo. *Neill & Co., Ltd.*

Fig. 1.

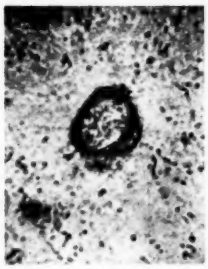

Fig. 2.

Fig. 3.

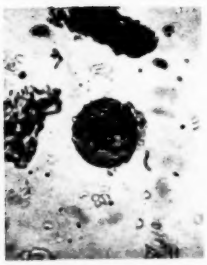

Fig. 4.

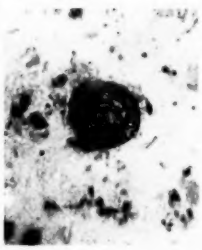

Fig. 5.

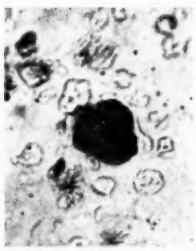

Fig. 6.

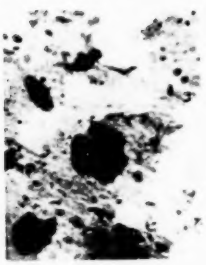

Fig. 7.

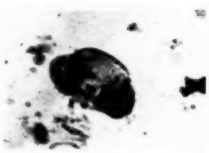

Fig. 8.

Fig. 9.

F. Kirchheimer, photo. *Neill & Co., Ltd.*

AN OUTLINE INVESTIGATION OF THE ESSENTIAL OIL OF *PTERONIA STRICTA* AIT.

By J. L. B. Smith and M. L. Sapiro.

In the George-Knysna area, where an infusion of its leaves is employed as a remedy for intestinal disorders, the shrub *Pteronia stricta* Ait. is known as " Katje Gert."

The air-dried leaves have been found to contain 1·8 per cent. of essential oil, which, extracted by steam distillation, is of a deep yellow colour and possesses a powerful " eucalyptus " odour. The freshly extracted oil has $D^{21} = 0{\cdot}924$, $n_D^{22} = 1{\cdot}477$, and $\alpha_D = +2{\cdot}5$.

The composition of the oil would appear to be approximately as follows :—

	Per cent.
Terpene hydrocarbons : Sylvestrene	2
(Phellandrene)	17
Cineole	50
Phenols and acids	1
Phenol ethers (Estragonole)	5
Esters	5
Alcohols	6
Residue, loss, etc.	14

The infusion of the leaves as generally prepared might be expected to act as a mild astringent and disinfectant, but, in common with many other similar preparations, is probably of doubtful medicinal value.

Experimental.

Steam distillation of 17 kg. of the air-dried leaves yielded 307 grams of dark yellow oil of pungent odour in which that of cineole predominated. The dry oil was found to have $D^{21} = 0{\cdot}924$, $n_D^{22} = 1{\cdot}477$, and $\alpha_D = +2{\cdot}5$.

Fractionation of the oil was carried out at the ordinary pressure, a short Dufton column being employed. When only limited amounts of oil are available, we have found that a *temperature-percentage distillate*

curve provides useful information. By using as receiver to the standard fractionation apparatus a slender, finely graduated cylinder, readings of distillate against temperature are readily obtained.

Careful and repeated fractionation of the present oil at 720 mm. yielded the following fractions, the physical constants and methoxyl contents of which are given below :—

Fraction.	° C.	Per cent. Distilling.	D^{25}.	n_D^{21}.	a_D.	Per cent. OMe.
Original oil	..	..	0·924	1·477	+ 2·5	1·1
f_1	–172	3·8	0·8939	1·4677	..	..
f_2	172–185	56·2	0·8971	1·4655	+21·3	..
f_3	185–205	13·0	0·9605	1·4838	..	1·34
f_4	205–225	4·4	0·9348	1·4940	..	4·11
f_5	225–240	3·1	0·9598	1·5013	..	2·57
f_6	240–260	3·1	0·9576	1·5601	..	2·28

Sylvestrene appeared to be present in the fraction f_1; with acetic anhydride and sulphuric acid the characteristic blue colour was produced. *Cineole* also was present in this fraction.

Fraction f_2, from its odour, obviously contained a large proportion of *cineole*. Iodole was added to the hot alcoholic solution of a small portion of the fraction f_2, when a yellow crystalline precipitate resulted. This was separated, washed with petrol ether, and recrystallised from hot alcohol, when the pure *cineole-iodole* compound was obtained. (M.pt. 112° ; mixed, melt with cineole-iodole compound prepared from pure cineole, 112°.) The estimation of cineole with any degree of accuracy presents some difficulty. The phosphoric acid method (U.S. Pharmacopoeia, 8th Rev.) was found to give fairly reliable and consistent results. By this method the original oil was found to contain 50·2 per cent. of cineole, and the fraction f_2 64·0 per cent.

Further investigation of the fraction f_2 failed to reveal the absolute identity of the remaining 36 per cent. It is believed to be mainly *Phellandrene*. The physical constants of and the percentages of carbon and hydrogen in the fraction f_2 correspond closely with the values calculated for a mixture of cineole (64·7 per cent.) and phellandrene (35·3 per cent.).

	D^{25}.	n_D^{17}.	a_D.	Per cent. C.	Per cent. H.
Found in fraction f_2 .	0·897	1·465	+21·3	80·7	11·6
Calculated for mixture.	0·897	1·463	+21·3	81·3	11·7

All attempts to prepare from the fraction f_2 the characteristic nitrosite of phellandrene failed. It was found that pure nitrosite of phellandrene was immediately decomposed to tarry matter by a small amount of the fraction f_2, and it would appear that if phellandrene was present in this fraction some other undetermined component prevented the formation of the nitrosite. Phellandrene occurs frequently with cineole in essential oils, and the evidence adduced supports the view that it was present in this case.

The fraction f_3 proved to contain a considerable amount of cineole, the remainder consisting probably of alcohols. The original oil was found to contain 5 per cent. of esters, calculated as linalyl acetate, and 6 per cent. of alcohols, as $C_{10}H_{17}OH$.

The original oil was extracted with caustic soda solution. The aqueous layer was separated, extracted with ether, filtered, and excess of acid added. Ether extraction of the acid solution yielded finally the semi-solid phenols and acids contained in the oil (1 per cent.). The odour was pungent and peppery, but the quantity of material was too small to permit of fuller investigation.

The original oil was found to contain 1·1 per cent. of methoxyl. As will be seen above, the methoxyl content is highest in the fraction f_4, distilling over 205–225°/720 mm. The presence of anethole or of estragonole could not definitely be established. A portion of the fraction f_4 was oxidised by permanganate. From the resulting solution a small amount of a crystalline acid was isolated, but there was not sufficient to permit of complete purification, and satisfactory evidence of its identity with anisic acid was not obtained. The odour and the taste of this fraction would, however, indicate that a certain amount of estragonole was present.

The air-dried leaves were found to contain 5·35 per cent. of ash, in which a considerable proportion of manganese was present.

The authors desire to express their gratitude to the Research Grant Board of South Africa for financial assistance which defrayed part of the costs of the investigation.

Rhodes University College,
Grahamstown.

A CONTRIBUTION TO THE CHEMISTRY OF *RAUWOLFIA NATALENSIS.*

By M. Rindl and P. W. G. Groenewoud.

(Department of Chemistry, Grey University College, Bloemfontein.)

At least three different trees indigenous to South Africa and belonging to the Natural Order Apocynaceae are included under the name " Quinine tree " (Koorsboom), namely, (1) *Rauwolfia natalensis*, (2) *Voacanga dregei*, (3) *Conopharyngia ventricosa* (*Tabernaemontana ventricosa*). Juritz states that the bark of the Transkeian " quinine tree " is antifebrile.* Bryant † refers to its use as a blood purifier and in the treatment of measles, urticaria, and other rashes. Several species of *Rauwolfia* are stated to be highly prized drugs in tropical countries, and alkaloids have been isolated from them as well as from closely related species of *Voacanga* and *Tabernaemontana*.‡ The only published record of a chemical investigation into the bark of the so-called South African quinine tree dates back as far as 1901.§ A description is given of the isolation and properties of a crystalline alkaloid. As the botanical identity of the bark used is open to question, and as subsequent work failed to confirm the earlier results, a preliminary investigation was carried out with the bark of all three trees known locally as " quinine tree " and enumerated above. As this investigation did not furnish any clue which might lead to establishing the identity of the bark examined in 1901, it was decided to carry out a more searching investigation into the bark of *Rauwolfia natalensis*. A more exhaustive investigation of the bark of the other two trees will be carried out at a later date.

Treatment of Bark according to the Stas-Otto Method.

For the Stas-Otto method 50 grams of the powdered bark were extracted with alcohol, acidified with tartaric acid, in the usual way. The alcoholic

* " The Urgency of a Definite Forward Movement in the Study of the Active Principles of South African Plants," South African Medical Record, 13th November 1915.

† " Zulu Medicines and Medicine Men," Annals of the Natal Government Museum, vol. ii, pt. 1, July 1909.

‡ Greshoff, Ber., xxiii, 2 (1890), 3543.

§ Report of the Senior Government Analyst (Cape of Good Hope), 1901, p. 58.

extract, which showed an intense green fluorescence, was evaporated to dryness on the water-bath and taken up with distilled water. Ether extracts nothing of interest from the acid aqueous solution. Chloroform gives an amorphous alkaloidal extract from which nothing definite could be isolated.

On extracting the solution, rendered alkaline by addition of excess of caustic soda, with ether, a fluorescent alkaloidal solution was obtained, which, however, could not be induced to crystallise. Chloroform removes practically nothing from the alkaline solution. The solution was now rendered ammoniacal by addition of an excess of ammonium chloride. The bulk of the alkaloid still seems to be retained by the ammoniacal solution. No alkaloid was removed by shaking this solution in turn with benzene, ether, chloroform, and amyl alcohol.

There appear to be at least three alkaloids in the bark: one removed by chloroform from the acid solution; the second extracted by ether from solution rendered alkaline by caustic soda, and possibly identical with the substance which renders the solution fluorescent; and one or more alkaloids more soluble in water than in organic solvents.

Bulk Extraction.

For purposes of bulk extraction the bark (10,000 grams) was reduced to a fine powder in an iron mortar and extracted by percolation with cold rectified spirit (distilled over solid sodium hydrate). The extraction was continued until the percolate, which was at first dark brown with a marked greenish fluorescence, became almost colourless. On concentrating under reduced pressure (15–20 mm. 45° C.) a fair amount of a granular solid (identified as cane sugar) separated. The concentrated residue was heated for a while on the steam-bath to remove the remainder of the solvent. But it remained pasty, and seemed to tenaciously retain a small amount of alcohol. This probably accounts for the difficulty experienced in obtaining a clear aqueous solution. On addition of water a fine brown suspension was formed, part of the material remaining undissolved. In order to remove the suspended material the liquid was heated, when the suspended material adhered to the sides of the vessel. The supernatant liquid was poured off and further diluted with water. Again a precipitate formed, which was removed as before. This process was repeated several times until a precipitate was no longer obtainable on further dilution. In order to remove any alkaloid still contained in the residue this was extracted with dilute acetic acid, and the acetic acid extract combined with the aqueous filtrate. On addition of excess of sodium carbonate solution a thick canary-yellow precipitate is thrown down which, on drying on a tile,

darkens and resinifies. To effect partial purification of the alkaloid, fractional precipitation with sodium carbonate was resorted to. On addition of a small amount of the precipitant a brown resinous precipitate is formed, which is of such a nature as to render filtration of the solution impossible. On standing for a few hours the resin is deposited and adheres to the side of the vessel so that the supernatant clear liquid can be decanted off. The process of fractional precipitation is continued by repeatedly adding small amounts of sodium carbonate solution, and stirring thoroughly each time to redissolve the portion more readily soluble in acid. After each addition the solution is allowed to stand in order to enable the resin to settle. Addition of sodium carbonate is continued until the solution is neutral or slightly alkaline. It is then filtered and an excess of precipitant is added, which throws down a copious canary-yellow precipitate which can be filtered by suction and which retains its colour on exposure and drying. Yield 25 grams, equivalent to 0·25 per cent.; but this does not represent the entire yield. On prolonged standing an appreciable amount of a very fine reddish-brown precipitate was formed. Part of it adhered to the sides of the container, but could easily be detached, and the bulk of the precipitate could easily be filtered by suction. Although this deposit is probably identical with the alkaloid obtained by fractional precipitation, it is obviously very much less pure, and it was accordingly kept apart.

The difficulty referred to above, of obtaining a clear solution on treating the dry alcoholic extract with water, was not experienced with an extract which had been allowed to stand for several months and had turned brittle. The precipitated alkaloid was extracted in turn with alcohol, ethyl acetate, benzene, carbon tetrachloride, acetone, ligroin, chloroform, methanol, and ether. In no case did the alkaloid dissolve completely, and the solutions on evaporation all gave amorphous residues.

Rauwolfia canescens, *R. serpentina*, *R. trifoliata*, *R. spectabilis*, and *R. madurensis* from Java yield a crystalline alkaloid (Rauwolfine) which gives a blood-red colour reaction with concentrated nitric acid, which is described as a characteristic and sensitive test.* The yellow alkaloidal precipitate described above does not give this Rauwolfine reaction.

Attempts to prepare crystalline salts of the alkaloid were as unsuccessful as endeavours to crystallise it from organic solvents. Further attempts were made to purify the alkaloid by dissolving in acetic acid and re-precipitating with sodium carbonate, but the product so obtained showed as little tendency to crystallise as the product obtained by the first precipitation.

* Greshoff, Ber., xxiii, 2 (1890), 3543.

Pharmacological Tests with Purified Alkaloid.

1. Oral administration of 0·027 gram per kg. body-weight to cat. Solution in dilute acetic acid. Normal temperature 101·2° F. After 5 hours 104·8°. After 11 hours back to normal. Animal quite lively.

2. Subcutaneous administration of 0·027 gram per kg. body-weight in very dilute acetic acid neutralised with sodium carbonate solution. Normal temperature 100·2° F. After 2 hours 103·6°. After 6 hours almost back to normal. Animal quiet throughout.

3. Oral administration of 0·1 gram per kg. in very dilute acetic acid. Normal temperature 101°, raised to 102° within an hour and a half. Temperature normal again after a further hour and a half. Animal very quiet throughout.

4. Subcutaneous administration of 0·1 gram per kg. in dilute acetic acid neutralised with sodium carbonate solution. Normal temperature 101·4°, raised to 103° within an hour and three-quarters. Temperature unaltered an hour later; back to normal next morning. Animal quiet throughout. The effect of the alkaloid in elevating the temperature is interesting and unexpected, inasmuch as the local name and reputed use of the bark suggested that it would be antifebrile.

Perchlorate of the Alkaloid.

A very small amount of the base was dissolved in dilute acetic acid and precipitated with pure seventy per cent. perchloric acid. An amorphous perchlorate is thrown down, which dissolves in excess of the precipitant, but is reprecipitated by addition of water. The precipitate is soluble in methanol, ethyl alcohol, ethyl acetate, and chloroform. From the last-named solvent it was obtained in needles which swell up and decompose at 110–113° C. without melting. Attempts to obtain a larger amount of the crystalline product unfortunately failed.

Extraction of the Alkaline Solution with Ether.

The original aqueous alkaline filtrate and the filtrate obtained from the acetic acid solution were combined and tested for alkaloids, with positive results. The ethereal extract was alkaloidal, and left an amorphous residue on evaporation of the solvent. The residue swells up and decomposes in the vicinity of 190° C., without showing any indication of melting. Subjected to high vacuum sublimation (185° C. and 0·002 mm.), the product turned from brown to red but gave no trace of a sublimate. Rauwolfine reaction with nitric acid positive. After removal of the

solvent the residue is only sparingly soluble in ether, suggesting that a change has taken place. Extracted residue with acetone. Incompletely soluble, leaving an amorphous residue on evaporation of the solvent. Attempts to obtain crystalline salts with hydrochloric, sulphuric, hydrobromic, and picric acids proved abortive. After treatment with acetone extracted with ethyl acetate, the ethyl acetate extract shows no tendency to crystallise and gives a positive Rauwolfine reaction. The residue left after extracting with ether, ethyl acetate, and acetone still contains some alkaloid. It also contains a substance capable of reducing gold chloride.

An attempt to prepare a crystalline picrate from the original ethereal solution failed, as did an attempt to obtain a crystalline methiodide (ether extract dissolved in methanol and heated with carefully purified methyl iodide in a sealed tube to 100° C. for 12 hours).

Ethyl Acetate Extract of Original Solution.

After exhaustion of the alkaline solution with ether it is extracted with ethyl acetate. The extract is alkaloidal and exhibits a strong green fluorescence. It does not respond to the Rauwolfine test. It appears, therefore, that the fluorescent substance is distinct from Rauwolfine and is of an alkaloidal nature. On removal of the solvent a resinous residue remains from which nothing crystalline could be obtained either by high vacuum sublimation or by evaporation of solutions in organic solvents. Attempts to prepare a crystalline sulphate, perchlorate, iodide, and picrate proved equally unsuccessful. Vitali's test, which is described in the report of the Senior Government Analyst previously quoted as being characteristic of the alkaloid extracted from the alleged *Rauwolfia* bark, was positive. The alkaloid was moistened with concentrated nitric acid, evaporated to dryness on a water-bath, and the dry residue moistened with a drop of alcoholic potassium hydroxide. A mauve or reddish colour was obtained, which almost immediately turned brown. This test was also applied to several extracts of the hot alcoholic percolation, and was always found to be positive, whether the Rauwolfine reaction was positive or not. Hence the test does not appear to be as specific as is claimed in the Government Analyst's report.

Hot Extraction.

As cold extraction did not exhaust the bark, continuous hot percolation with alcohol in a large copper Soxhlet was resorted to. It transpired that a considerable amount of alkaloidal material had been left in the bark, which was removed by this treatment. The course adopted with the cold

extract was again followed, the alkaloid precipitated from the aqueous solution being redissolved in dilute acetic acid and fractionally precipitated with sodium carbonate three times in all. As the product thus purified refused to crystallise from any of the ordinary solvents, attempts were made with nitrobenzene, phenol, and tetralin, but with equally discouraging results. The alkaline filtrates from the original precipitation with sodium carbonate were extracted by continuous warm percolation with ether, but yielded nothing of interest.

Subsequent extraction with cold ethyl acetate gave a fluorescent solution with positive Rauwolfine reactions. The extract differs in this respect from the ethyl acetate extract of the corresponding cold alcoholic percolation, thus indicating that hot extraction with alcohol not only exhausts the bark more completely, but also gives different products. Vitali's test positive. Chloroform and amyl acetate extracts nothing definite. Vitali's test positive in the former case. The results are being submitted in the form of a joint publication at this juncture, as the investigation is being continued by the second author at the University of Vienna.

Summary and Conclusion.

The bark of the so-called " quinine tree " (Koorsboom) is credited with possessing medicinal virtues. In South Africa three trees belonging to the Natural Order Apocynaceae are included under this name : *Rauwolfia natalensis*, *Voacanga dregei*, and *Conopharyngia ventricosa* (*Tabernaemontana ventricosa*). In the Report of the Senior Government Analyst (Cape of Good Hope) for 1901, p. 58, the isolation of a crystalline alkaloid from the bark of the quinine tree is recorded. The botanical identity of the plant on which this investigation was carried out is doubtful. In an endeavour to establish the identity of the bark used and to corroborate the results recorded in the Analyst's Report a cursory investigation of the bark of the three trees enumerated above was carried out by the authors. In no case could anything be isolated which even remotely resembled the alkaloid recorded in the earlier literature. The bark of *Rauwolfia natalensis* was thereupon subjected to a searching investigation. The cold alcoholic percolate furnishes—

(*a*) Cane sugar.

(*b*) An amorphous yellow alkaloid which, when administered orally or subcutaneously to cats in doses of 27 mg. or more per kg. body-weight, causes an elevation of temperature. This result is interesting inasmuch as the local name and reputed use of the bark suggested that it would have an antipyretic effect. The alkaloid has no definite melting-point, and it resisted all attempts to obtain it or one of its derivatives in crystalline

form. It is obtained by fractional precipitation of the aqueous solution with sodium carbonate.

(*c*) An amorphous alkaloid extracted from the aqueous alkaline solution with ether and giving the Rauwolfine reaction with concentrated nitric acid. This reaction is stated to be characteristic of the crystalline alkaloid which occurs in several tropical *Rauwolfia* species.

(*d*) An amorphous alkaloid extracted from the aqueous alkaline solution with ethyl acetate and giving a fluorescent solution. This alkaloid does not give the Rauwolfine reaction.

(*e*) One or more alkaloids which appear to be very soluble in water and are not removed from the aqueous alkaline solution by shaking with immiscible solvents.

As cold extraction failed to exhaust the bark, continuous hot percolation with alcohol in a large copper Soxhlet was resorted to. In the absence of any well-defined products it is difficult to say whether, and to what extent, the products so obtained differ qualitatively from those obtained by cold percolation. The only definite difference which it is possible to record at this stage is the extraction by *ethyl acetate* of a substance giving the Rauwolfine reaction. In the case of the cold percolation a product answering to this test was obtained only from the ether extract.

The Vitali reaction, which was described as characteristic of the alkaloid isolated in the earliest investigation recorded in the annual report of the Government Analyst, was found to be given by quite a number of extracts obtained with different solvents.

Acknowledgments.

The authors desire to express their indebtedness to Dr. Florence V. Stephen of the Department of Pharmacology of the University of the Witwatersrand for carrying out the pharmacological tests, and to the Chief Conservator of Forests and his staff for obtaining supplies of bark for the investigation. Acknowledgments are also made to the Research Grant Board of the Union for a research grant, part of which was used to defray the expenses of the investigation.

NOTE ON A SET OF EQUIVALENT DETERMINANTS CONNECTED WITH A 3-BY-6 ARRAY.

By Sir Thomas Muir, F.R.S.

1. The mere existence of such a set of equivalents is a fact worth drawing attention to, and interest in them is enhanced on learning the story of their origin. They are seven in number—three of the 6th order, one of the 4th, one of the 3rd, and two of the 2nd. They thus may conveniently be denoted by

$$\Delta_6,\ \Delta_6',\ \Delta_6'',\ \Delta_4,\ \Delta_3,\ \Delta_2,\ \Delta_2'\ ;$$

and if the array of their variables be

$$\begin{matrix} x_1 & x_2 & . & . & . & . & x_6 \\ y_1 & y_2 & . & . & . & . & y_6 \\ z_1 & z_2 & . & . & . & . & z_6, \end{matrix}$$

they are in order

$$\begin{vmatrix} x_1^2 & y_1^2 & z_1^2 & y_1z_1 & z_1x_1 & x_1y_1 \\ x_2^2 & y_2^2 & z_2^2 & y_2z_2 & z_2x_2 & x_2y_2 \\ . & . & . & . & . & . \\ x_6^2 & y_6^2 & z_6^2 & y_6z_6 & z_6x_6 & x_6y_6 \end{vmatrix} \text{ i.e. } \Delta_6,$$

$$\begin{vmatrix} x_1x_2 & y_1y_2 & z_1z_2 & y_1z_2+y_2z_1 & z_1x_2+z_2x_1 & x_1y_2+x_2y_1 \\ x_2x_3 & y_2y_3 & z_2z_3 & y_2z_3+y_3z_2 & z_2x_3+z_3x_2 & x_2y_3+x_3y_2 \\ x_3x_1 & y_3y_1 & z_3z_1 & y_3z_1+y_1z_3 & z_3x_1+z_1x_3 & x_3y_1+x_1y_3 \\ . & . & . & . & . & . \\ x_6x_4 & y_6y_4 & z_6z_4 & y_6z_4+y_4z_6 & z_6x_4+z_4x_6 & x_6y_4+x_4y_6 \end{vmatrix} \text{ i.e. } \Delta_6',$$

$$\begin{vmatrix} \begin{vmatrix} x_1y_2 \\ y_1z_2 \\ z_1x_2 \end{vmatrix} & \begin{vmatrix} x_4y_5 \\ y_4z_5 \\ z_4x_5 \end{vmatrix} & \begin{vmatrix} x_2y_3 \\ y_2z_3 \\ z_2x_3 \end{vmatrix} & \begin{vmatrix} x_5y_6 \\ y_5z_6 \\ z_5x_6 \end{vmatrix} & . & . \\ . & . & \begin{vmatrix} x_2y_3 \\ y_2z_3 \\ z_2x_3 \end{vmatrix} & \begin{vmatrix} x_5y_6 \\ y_5z_6 \\ z_5x_6 \end{vmatrix} & \begin{vmatrix} x_3y_4 \\ y_3z_4 \\ z_3x_4 \end{vmatrix} & \begin{vmatrix} x_6y_1 \\ y_6z_1 \\ z_6x_1 \end{vmatrix} \end{vmatrix} \text{ i.e. } \Delta_6'',$$

$$\begin{vmatrix} |x_1y_2z_3| & . & . & |x_4y_2z_3| \\ |x_1y_4z_5| & |x_2y_4z_5| & . & . \\ |x_1y_5z_6| & |x_2y_5z_6| & |x_3y_5z_6| & |x_4y_5z_6| \\ . & . & |x_3y_6z_1| & |x_4y_6z_1| \end{vmatrix} \text{ i.e. } \Delta_4,$$

$$\begin{vmatrix} \begin{vmatrix} |z_1x_2| & |x_1y_2| \\ |z_4x_5| & |x_4y_5| \end{vmatrix} & \begin{vmatrix} |x_1y_2| & |y_1z_2| \\ |x_4y_5| & |y_4z_5| \end{vmatrix} & \begin{vmatrix} |y_1z_2| & |z_1x_2| \\ |y_4z_5| & |z_4x_5| \end{vmatrix} \\ \begin{vmatrix} |z_3x_4| & |x_3y_4| \\ |z_6x_1| & |x_6y_1| \end{vmatrix} & \begin{vmatrix} |x_3y_4| & |y_3z_4| \\ |x_6y_1| & |y_6z_1| \end{vmatrix} & \begin{vmatrix} |y_3z_4| & |z_3x_4| \\ |y_6z_1| & |z_6x_1| \end{vmatrix} \\ \begin{vmatrix} |z_5x_6| & |x_5y_6| \\ |z_2x_3| & |x_2y_3| \end{vmatrix} & \begin{vmatrix} |x_5y_6| & |y_5z_6| \\ |x_2y_3| & |y_2z_3| \end{vmatrix} & \begin{vmatrix} |y_5z_6| & |z_5x_6| \\ |y_2z_3| & |z_2x_3| \end{vmatrix} \end{vmatrix} \text{ i.e. } \Delta_3,$$

$$\begin{vmatrix} |x_1y_2z_6| & |x_1y_3z_4| & |x_3y_4z_5| & |x_1y_4z_6| \\ |x_1y_2z_3| & |x_2y_5z_6| & |x_4y_5z_6| & |x_2y_3z_5| \end{vmatrix} \text{ i.e. } \Delta_2,$$

$$\begin{Vmatrix} x_1^2 & y_1^2 & z_1^2 & y_1z_1 & z_1x_1 & x_1y_1 \\ x_4^2 & y_4^2 & z_4^2 & y_4z_4 & z_4x_4 & x_4y_4 \end{Vmatrix} \cdot \begin{Vmatrix} |y_2z_3| & |y_5z_6| & \dots & |z_2x_3| & |x_5y_6| + |z_5x_6| & |x_2y_3| & \dots \\ |y_2z_6| & |y_5z_3| & \dots & |z_2x_6| & |x_5y_3| + |z_5x_3| & |x_2y_6| & \dots \end{Vmatrix}$$

where in the second factor here the rows are formed as in Δ_6'.

The first made known of the seven was Δ_6'', which was given in the year 1843 by Cayley in a paper dealing with a question of coordinate geometry: there also Δ_4 was given as an equivalent.*

Another pair, Δ_3 and Δ_2 in its expanded form, were in similar manner made known as being equal in 1875–6 by Hunyady, but without any reference to Cayley or to the first pair.†

A year or so thereafter Mertens, starting from Δ_3 like Hunyady and doubtless aware of Hunyady's doings, produced ‡ a more elegant pair of equals, Δ_6 and Δ_6'.

Then in 1882 Hunyady returned to the subject,§ and in the course of establishing the known equivalence of Mertens' Δ_6 with his own Δ_2 indirectly put on record a fifth equivalent Δ_2' in the form of the product of a pair of 2-by-6 arrays.

Lastly, in 1889 Cayley's Δ_6'' and Δ_4 were brought within the fold by Muir's proof ‖ that $\Delta_4 = \Delta_2$.

3. Manifestly there is here offered to the student a ready source of identities for proof by transformation, a source too that is likely to repay attention, as it would seem to have been almost entirely neglected, only two other writers having given any thought ¶ to the subject.

* Cambr. Math. J., iv, pp. 18–20.

† Crelle's J., lxxxiii, pp. 76–85.

‡ Crelle's J., lxxxiv, pp. 355–359.

§ Crelle's J., xcii, pp. 307–310.

‖ Proc. R.S.E., xvii, pp. 18–22.

¶ Scholtz, A., Archiv d. Math. u. Phys., lxii, pp. 317–324; Pasch, M., Crelle's J., lxxxix, pp. 247–251.

4. A prominent example of such desired transformations is that of Δ_6 into the final form of Δ_2,—that is to say, a direct proof of the identity

$$\begin{vmatrix} x_1^2 & y_1^2 & z_1^2 & y_1z_1 & z_1x_1 & x_1y_1 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ x_6^2 & y_6^2 & z_6^2 & y_6z_6 & z_6x_6 & x_6y_6 \end{vmatrix} = \begin{matrix} |\, x_1y_2z_6 \,| \cdot |\, x_1y_3z_4 \,| \cdot |\, x_2y_3z_5 \,| \cdot |\, x_4y_5z_6 \,| \\ - |\, x_1y_2z_3 \,| \cdot |\, x_1y_4z_6 \,| \cdot |\, x_2y_5z_6 \,| \cdot |\, x_3y_4z_5 \,|, \end{matrix}$$

which may be described as the expression of the determinant Δ_6 in the form of the difference of two 4-factor products of 3-line minors of the basic array.

5. The striking feature of this identity is the simplicity of the law of formation of the left-hand member in contrast with the complexity of the right-hand. Hunyady must have felt conscious of this complexity, for he gave himself considerable trouble in seeking out fourteen other differences like the right-hand member,—like, that is to say, in being equal to Δ_6 and being formed from eight of the 3-line minors of the basic array.

6. In view of such labour the following rule of formation is worth noting, if only as affording a substitute for repeated consultations of Hunyady's table of fifteen. *Take any permutation of the first six integers, say* 314256 : *write this cyclically*

$$\begin{matrix} & 3 & \\ 6 & & 1 \\ 5 & & 4 \\ & 2 & \end{matrix}$$

Choose any three consecutive integers of the cycle, say 314 : *then beginning with the last of the triad,* 4, *form another consecutive three,* 425 : *next form similarly* 563 : *and finally make a triad of the middle members of the triads already obtained,* 126. *There thus emerges one of the wanted products.*

$$|\, x_3y_1z_4 \,| \cdot |\, x_4y_2z_5 \,| \cdot |\, x_5y_6z_3 \,| \cdot |\, x_1y_2z_6 \,| \,;$$

and the other is got in exactly similar fashion from the same cycle by beginning a place further on, thus

$$|\, x_1y_4z_2 \,| \cdot |\, x_2y_5z_6 \,| \cdot |\, x_6y_3z_1 \,| \cdot |\, x_4y_5z_3 \,| \,.$$

The difference of these two products is the 5th of Hunyady's list : and if another example be needed for illustration we may take the first permutation of all, 123456, to which the application of the rule gives us, in shortened notation,

$$123 \cdot 345 \cdot 561 \cdot 246 - 234 \cdot 456 \cdot 512 \cdot 351,$$

and this is Hunyady's No. 2 changed in sign.

This last suggests that it would seem more natural to take as our standard form of Δ_2

$$\begin{vmatrix} 123 \cdot 345 \cdot 561 & 153 \\ 234 \cdot 456 \cdot 612 & 642 \end{vmatrix},$$

which has the advantage, too, of being easily remembered.

7. Since the same result is reached whatever place in the cycle we start from, and whether we go clockwise in forming our triads or counterclockwise, we see that the result may be viewed as originating with any one of 12 permutations

314256, 365241
142563, 136524
425631, 413652
256314, 241365
563142, 524136
631425, 652413.

Further, as from any one of these, say the first

314256,

we can obtain three others like it in their effect

214356,
354216,
316254,

by interchanging one of its first three members with the corresponding one of its last three, we have altogether 2×4 permutations originating the same Hunyady difference. Support is thus given to Hunyady's limitation of the number of such differences to

$$\frac{6!}{12 \times 4} \quad \text{i.e.} \quad 15.$$

Rondebosch, S. Africa,
1*st June* 1932.

GERMANIUM.

Part X.—The System Sodium Germanate-Water. Conductivity and Freezing-point Measurements, Heterogeneous Equilibria.

By W. Pugh.

(With two Text-figures.)

Conductivity measurements alone do not necessarily give accurate information about the condition in solution of salts of strong bases and weak acids. Thus, Kohlrausch (5) inferred from the high conductivity of sodium silicate in moderately dilute solution that the salt was completely hydrolysed, and this view persisted until Bogue (1) and Harman (2) showed, by actual measurement of the hydrogen-ion concentration, that hydrolysis was comparatively small.

So, then, the fact that dilute solutions of sodium germanate are good conductors means little in itself. The conductivity depends upon the number and kind of ions produced in solution. The number of ions present can be determined, however, with a fair degree of approximation by the freezing-point method, and this knowledge, in conjunction with conductivity measurements, will give a good idea of the extent of the hydrolytic process.

These measurements of conductivity and freezing-point lowering were carried out a number of years ago. Since then, actual measurements of the degree of hydrolysis have been made by the author (8) and by Schwarz (9) by determining the hydrogen-ion concentration of the solution. The author calculated the degree of hydrolysis, assuming hydrolysis to take place to the bi-germanate stage. Schwarz assumed hydrolysis to the second stage. Taking this difference into consideration, the values obtained by the two authors agree fairly well for the dilute solutions.

Inasmuch as the conductivity and freezing-point measurements lead to the same conclusions, and inasmuch as they afford an interesting comparison between carbon, silicon, and germanium, they are collected and recorded here.

Preparation of Sodium Germanate.—The material was prepared by the method described in a previous paper (8). It was purified as follows: The crystals were washed on a Büchner funnel with 50 per cent. aqueous alcohol and then redissolved in the minimum quantity of hot 40 per cent.

alcohol containing a little caustic soda. The fine crystals obtained on cooling and seeding were again separated on a Büchner, washed with aqueous alcohol, and finally with absolute alcohol and ether. They were then dried for an hour in the air. Analysis: Found—Na_2O, 21·17; GeO_2, 35·90; H_2O, 42·90 per cent. Required for $Na_2GeO_3.7H_2O$—Na_2O, 21·18; GeO_2, 35·73; H_2O, 43·08 per cent.

Evidently a small amount of hydrated germanium dioxide had been co-precipitated with the heptahydrate. There was a considerable residue left when it was dissolved in conductivity water. The whole material was therefore recrystallised once more from very dilute caustic soda, free from carbonate, over concentrated sulphuric acid *in vacuo*. The crystals were washed well with ice-cold water and were dissolved without previous drying in conductivity water. Only in this way could perfectly clear solutions be obtained. This was therefore the procedure adopted in preparing the material for all the work described herein, and such material always analysed within the limits of experimental error to pure heptahydrate.

Conductivity.

Since a high-frequency generator as a source of alternating current and some of the other refinements in conductivity-measuring apparatus developed by Washburn were not available, the ordinary method of Kohlrausch had to be employed in this work. A small induction coil giving a note of high pitch was used as a source of alternating current, and a sensitive telephone was used to determine the point of balance. The bridge wire, about ten metres long, was wound on a rotating drum. It was carefully calibrated before use. The conductivity cell was of the ordinary type, made of resistance glass and fitted with a ground-glass stopper. The effect of capacity in the cell was compensated by placing a variable condenser in the resistance arm of the bridge. The temperature was maintained at 25° C. $\pm$ 0·05 by means of a water thermostad electrically heated and controlled.

All parts of the apparatus were placed on a well-earthed plate, and the cell, resistances, and bridge wire were also shielded from one another.

The water employed for making and diluting the solutions made had a specific conductivity of 1 to $1{\cdot}2 \times 10^{-6}$ mhos. It was considered unnecessary to make highly purified conductivity water on account of the uncertainty with regard to the purity of the solute. Although the material analysed within the limits of experimental error to pure sodium germanate, it is not possible to say that it was entirely free from alkali or from co-precipitated germanium dioxide. The material must be crystallised from alkali to prevent the separation of germanium dioxide, and it is not possible

to expect such a degree of purity as can be expected in a material which can be crystallised from pure water.

The stock solution was made in a well-aged, alkali-resistant flask by dissolving the moist crystals in conductivity water. Its concentration was determined by titration with standard acid, using methyl red as indicator (8). Three other solutions were made from it by dilution in carefully calibrated flasks. Intermediate dilutions were obtained by withdrawing portions from the cell and replacing with an equal volume of conductivity water by means of calibrated pipettes.

Since the conductivity of the solutions was found to diminish on standing during the first few hours, the determinations were made only after the solutions had stood for twelve hours.

TABLE I.—*Conductivity Changes with Dilution.*

Gram-equiv. per litre.	Volume containing 1 gram-equiv. (V).	Spec. cond. $k \times 10^{-3}$.	Equiv. cond. $\lambda = kV \times 10^{-3}$.
0·630	1587 c.c.	43·48	67·6
0·315	3175 ,,	30·10	94·0
0·01575	6349 ,,	17·94	111·0
0·07875	12698 ,,	10·22	125·4
0·03938	25397 ,,	5·381	136·1
0·01969	50794 ,,	2·863	145·4
0·009845	101588 ,,	1·501	152·5
0·004922	203176 ,,	0·7730	157·1
0·002461	406352 ,,	0·3951	160·5
0·001230	812704 ,,	0·2006	163·0
0·000615	1625410 ,,	0·1011	164·0

Experimental Results.—The results obtained are given in Table I, which shows the change in equivalent conductivity with dilution. It is clear that sodium germanate is a very good conductor in dilute solution. Undoubtedly this is due chiefly to the presence of the very mobile hydroxyl ion produced by hydrolysis, though no exact quantitative conclusions can be drawn from the results.

Equivalent Conductivity at Infinite Dilution.—In fig. 1 the equivalent conductivity is plotted against the logarithm of the dilution. The curve conforms to the type for which extrapolation for λ_∞ is considered valid, and the value obtained in this way is approximately 165. This is in good agreement with the value derived by the method of Noyes and Falk (7). This method makes use of the expression,

$$\frac{1}{\lambda} = \frac{1}{\lambda_\infty} + K(C\lambda)^{n-1},$$

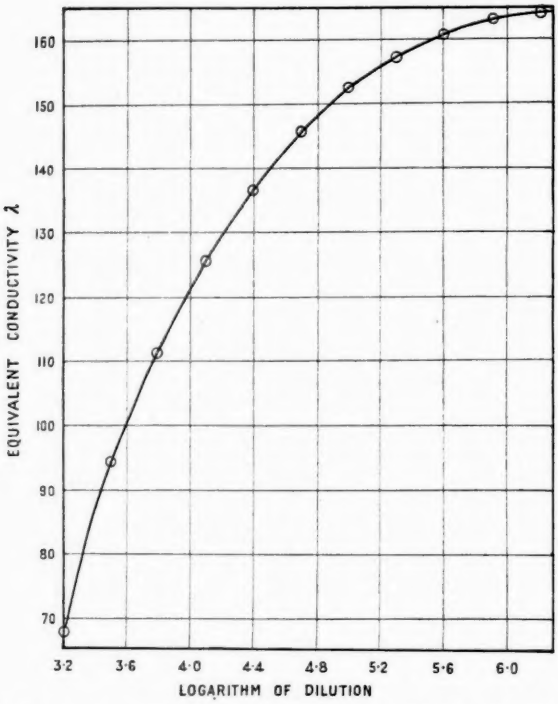

FIG. 1.—Equivalent conductivity plotted against logarithm of volume in c.c. containing 1 grm. equivalent.

and consists in plotting the values of $\frac{1}{\lambda}$ against those of $(C\lambda)^{n-1}$ for different values of n. The curve which is the nearest approximation to a straight line is then extrapolated to cut the $\frac{1}{\lambda}$ axis. The value of λ_∞ obtained in this way is 166.

It is interesting now to compare the equivalent conductivities of sodium carbonate, sodium silicate, and sodium germanate. This is done in Table II.

The values for sodium silicate are those obtained by Harman (3). The first two values for sodium carbonate have been obtained by interpolation from the results of Jones and West (4), and the value for λ_∞ is that given by Kohlrausch (6), corrected to 25° by making use of the temperature coefficient 0·0265, as given in Landolt Börnstein (4th ed., p. 1115).

TABLE II.—*Comparison of λ for Sodium Carbonate, Sodium Silicate, and Sodium Germanate.*

V (litres).	λNa_2CO_3.	λNa_2SiO_3.	λNa_2GeO_3.
10	76·7	130	121
200	108·7	158	157·5
inf.	152	160	166

It is evident that sodium germanate is a poorer conductor than sodium silicate in dilute solutions, although the degree of hydrolysis of the germanate is higher at the same dilution (8). This may be due to greater mobility of the silicate ions or to greater ionisation of the non-hydrolysed silicate.

DEPRESSION OF THE FREEZING-POINT.

The increase in the number of ions produced in solution with progressive dilution is shown in Table III, where the data obtained for freezing-point lowering of sodium germanate are given. These data were obtained by the usual laboratory or Beckmann method, and the usual precautions which are necessary for the maximum possible accuracy with the method were taken. The temperature of the cooling bath was maintained at about 2° below the freezing-point of the solution, and the degree of supercooling was not allowed to exceed 0·3°. Innoculation with a tiny crystal of ice was usually necessary.

TABLE III.

Concentration, mols./litre. m.	Observed lowering. Δ.	Molecular depression. $\frac{\Delta}{m}$.	van 't Hoff Factor. $i=\frac{\Delta}{1{\cdot}86m}$.
0·100	0·574	5·74	3·09
0·050	0·309	6·18	3·32
0·025	0·168	6·72	3·61
0·010	0·074	7·40	3·98
0·005	0·040	8·00	4·30

Although this method has no claim to great accuracy, the results are sufficiently correct to see that solutions of the order of 0·01 molar are almost completely hydrolysed in the sense of the equation:

$$Na_2GeO_3 + H_2O \rightleftharpoons 2Na^{\bullet} + OH' + HGeO_3' ;$$

or 50 per cent. hydrolysed in the sense of the equation :

$$Na_2GeO_3 + 2H_2O \rightleftharpoons 2Na^{\bullet} + 2OH' + H_2GeO_3.$$

This is in agreement with the result derived by the author from E.M.F. measurements (8).

Heterogeneous Equilibria.

The composition of saturated solutions of sodium germanate in water at different temperatures, and the nature of the solid phase in contact with

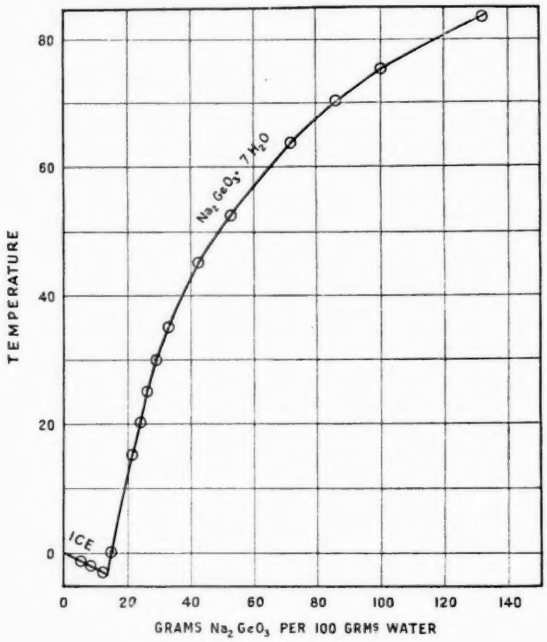

Fig. 2.

them, were determined partly by the freezing-point method and partly by the solubility method. At temperatures below 0°, the freezing-point method alone was used. At temperatures between 0° and 45°, the solubility method was employed. In some cases, saturation was reached from both supersaturated and unsaturated sides and the results always agreed closely. It was not possible, however, to extend the solubility method beyond 45° owing to the great solubility of the substance and the limited

quantity of it available. The few points determined above this temperature were obtained again by the freezing-point method. Only small quantities, enough to cover the bulb of the thermometer, are needed for this method. The thermometer employed was calibrated in tenths of a degree, and it was checked carefully before use against a standard thermometer.

The concentrated solutions dealt with at these temperatures are very viscous and, consequently, equilibrium was slowly set up. It was therefore necessary to guard against supercooling. This was done by packing the tube well with thick wads of cotton-wool during the cooling process, so that the temperature drop was not more than 0·5° per minute in the neighbourhood of the freezing-point. The liquid was also innoculated with a small crystal of the solid phase. The actual freezing-point was then determined by plotting time-temperature curves. The data obtained are given in Table IV and are plotted in fig. 2. Densities of some of the solutions are included in Table IV.

TABLE IV.—*Temperature—Composition Relations.*

Temperature, °C.	Concentration, grams Na_2GeO_3/100 grams water.	Solid phase.	D'_4.
− 0·7	2·38	ice	
− 1·50	5·53	,,	
− 2·0	8·04	,,	
− 2·4	10·23	,,	
− 3·0	12·40	,,	
0·0	14·50	$Na_2GeO_3.7H_2O$	
15·2	21·40	,,	1·1992
20·2	23·70	,,	1·2168
25·0	25·90	,,	1·2344
30·0	28·65	,,	1·2590
35·0	32·60	,,	
45·0	42·0	,,	
52·5	52·7	,,	
63·5	72·0	,,	
70·5	85·5	,,	
75·5	99·6	,,	
83·5	132	,,	

The only solid phases in the system up to the melting-point of the heptahydrate, the highest temperature at which determinations were made, are ice and sodium germanate heptahydrate. A large-scale plot of these results shows that the eutectic occurs at − 3·2° and contains 13·1 grams of sodium germanate per 100 grams of water.

In conclusion, as I am now leaving this field of investigation, I wish to express my thanks to the University of Cape Town for the facilities that have been placed at my disposal for carrying out this work, and especially for a grant for the purchase of necessary apparatus. I have also much pleasure in placing on record my gratitude to Professor J. Smeath Thomas for the loan of the material with which the whole of this work has been done, and for his constant interest and advice at all times.

LITERATURE CITED.

(1) Bogue.—Journ. Amer. Chem. Soc., 1920, vol. xlii, p. 2575.
(2) Harman.—Journ. Phys. Chem., 1926, vol. xxx, p. 1100.
(3) Harman.—*Ibid.*, 1925, vol. xxix, p. 1155.
(4) Jones and West.—Amer. Chem. Journ., 1905, vol. xxxiv, p. 378.
(5) Kohlrausch.—Z. Physik. Chem., 1893, vol. xii, p. 773.
(6) Kohlrausch.—Wied. Annal., 1885, vol. xxvi, p. 204.
(7) Noyes and Falk.—Journ. Amer. Chem. Soc., 1912, vol. xxxiv, p. 462.
(8) Pugh.—Journ. Chem. Soc., 1929, p. 1997; *ibid.*, 1926, p. 2829.
(9) Schwarz.—Ber., 1929, vol. lxii, p. 2483.

CONTRIBUTIONS TO THE FLORA OF THE KNYSNA AND NEIGHBOURING DIVISIONS.

By H. G. Fourcade.

In preparing a list of the flowering plants found in the divisions of George, Knysna, Humansdorp, and Uniondale, based chiefly on my own collections at intervals during many years, I wished to include the new species collected by me that were still undescribed, and with this object have supplied their descriptions in the present paper. I have added the name changes in my list that have been rendered necessary by the international rules of botanical nomenclature. In testing the numerous new combinations that have already been made by others since the publication of the Flora Capensis, I found a number of illegitimate changes which I have taken the opportunity to rectify. But I have avoided making any changes or corrections that did not concern my list.

My obligations to many others for help in naming my plants will be more appropriately acknowledged in the main paper, but I am specially indebted to Sir Arthur W. Hill, F.R.S., Director of the Royal Botanic Gardens, Kew, for allowing me the facilities to work in the Kew Herbarium and its Library, without which the present work could not have been completed. I have to thank, too, Mr. J. Hutchinson, F.L.S., for invaluable advice and assistance during its progress.

MONOCOTYLEDONES.

Amaryllidaceae.

Spiloxene, Salisb. em.

In 1914 Nel (Engl. Jahr., li, 243, 290) revived *Ianthe*, Salisb., Gen. Pl. Fr., 44 (1866), including *Spiloxene*, Salisb., *ibid.*, as distinct from *Hypoxis*, L., into which last the first two genera had been replaced by Baker and others. But he overlooked the priority of *Janthe*, Griseb. Spicil. Fl. Rumel., ii, 40 (1844) = *Celsia*, L. (Scroph.), which makes both *Ianthe*, Salisb., and *Janthe*, Nel, invalid. Nel says: "Die unterscheide zwischen Spiloxene und Janthe sind kaum aufrecht zuerhalten, und Spiloxene wird jetz allgemein mit Janthe vereinigt." Accepting this view, *Spiloxene*, Salisb. em., is now made, conversely, to include *Ianthe*, Salisb., and

substituted for *Janthe*, Nel. The type species is *Spiloxene stellata* (L.f.), Salisb. = *Hypoxis stellata*, L.f., and the new combinations required are—

Spiloxene alba (L.f.), comb. nov. = *Hypoxis alba*, L.f.
S. aquatica (L.f.), comb. nov. = *H. aquatica*, L.f.
S. minuta (L.f.), comb. nov. = *H. minuta*, L.f.
S. trifurcillata (Nel), comb. nov. = *Janthe trifurcillata*, Nel.

CYPERACEAE.

Ficinia dispar (Spreng.), comb. nov.
Schoenus dispar, Spreng., Neue Entd., 3, 8 (1822).
F. secunda, Kunth, Enum., 2, 262 (1837).

Ficinia marginata (Thunb.), comb. nov.
Scirpus marginatus, Th., Prodr., 17 (1794).
F. filiformis, Schrad., Anal. Fl. Cap., 46 (1832).

Ficinia Pseudoschoenus (Steud.), comb. nov.
Scirpus Pseudoschoenus, Steud., Flora, 1829, p. 147.
F. albicans, Nees, Linn., 10, 175 (1836).

Scirpus striatus (Nees), comb. nov.
Eleogiton striatus, Nees, Linn., 9, 291 (1832).
S. capillifolius, Parl., Fl. Ital., 2, 83 (1852).

Tetraria compressa, Turrill. The type is No. 2963 from Lower Zitzikamma flats, near Kromme River, 500 ft., February 1924, and was sent to Kew by Dr. Schönland under a wrong number, No. 2600, which is quoted as the type number in Kew Bull., No. 2, 1925. No. 2600 is a fruiting branch of the same species, collected in the same locality in May 1923.

GRAMINEAE.

Imperata cylindrica, Beauv., Agrost., 165 (1812).
I. cylindrica (Beauv.), Druce (1917).
I. arundinacea, Cyr. var. *Thunbergii* (Hack.).

Panicum Stapfianum, nom. nov.
P. minus, Stapf. (1899), non Nash (1895) = diffusum.

Pennisetum Thunbergii, Kunth.
P. geniculatum (Th.) Leeke (1907), non Jacq. (1820).

IRIDACEAE.

Anapalina longituba, sp. nov.

Affinis *A. revolutae* (Burm.), N. E. Br., sed floribus laete roseo-rubris, perianthii tubo longiore nervosiore inferne gracili superne infundibuliformi, staminibus perianthii segmentis brevioribus, styli ramis bifidis differt.

Corm large, globose; outer tunics breaking into dense brown fibres, inner produced past the neck as flattened bristles. Peduncles terete, simple,

45–60 cm. long. Basal leaves 3–4, ensiform, acute, 20–30 cm. long, 10 mm. broad at the middle, with 4 strong ribs. Flowers rose-red, arranged in a distichous spike 5–8 cm. long. Spathe valves ovate-lanceolate, firm in texture, brown, 10–20 mm. long and 4–5 mm. broad. Perianth tube curved, 30–40 mm. long, very slender in the lower third, then dilated gradually to a diameter of about 4 mm. ; upper third of perianth tube funnel-shaped ; segments of limb spathulate, obtuse or emarginate, 4–5 mm. broad above, the upper segment about 40 mm. long and the remainder 5–8 mm. shorter. Stamens one-third shorter than the perianth segments ; anthers linear-lanceolate, 5–6 mm. long, apiculate. Style the length of the stamens ; style branches 3–4 mm. long, bifid 1 mm. down.

Near *A. revoluta* (Burm.), N. E. Br., but differs by the longer and more curved perianth tube, its slender lower portion and funnel-shaped upper portion, by the stamens shorter than the perianth segments, the bifid style branches and the bright rose-red colour of the flowers.

Div. Uniondale : Prince Alfred's Pass, 2900 ft., March 1922, *Fourcade* 2063.

Hesperantha linearis (Jacq.), comb. nov.

Ixia linearis Jacq. Ic., t. 279 (1786–93), Coll., 4, 183 (1790).

I. angusta, Willd., Sp. Pl., i, 202 (1798).

H. angusta (Willd.) Ker.

Tritonia chrysantha, sp. nov. [Gladioleae].

Affinis *T. securigerae* Ker, sed florum colore flavo, perianthii tubo longissimo et graciliore, foliis majoribus, stylo staminibus breviore differt.

Corm globose, 15 mm. in diameter ; tunics of matted anastomosing fibres. Stem slender, terete, simple or branched, 14–23 cm. long. Leaves 5–6, ensiform, distichous, obtusely acuminate, 5–13 cm. long and 6–10 mm. broad. Flowers 3–5 in a lax distichous spike ; spathe valves 5–7 mm. long, oblong, membranous, brown-lineolate near the tips, the outer with 7–9 nerves, the inner bifid with the medial nerve of each lobe produced into an apiculus ; perianth bright yellow with a tube 15–25 mm. long, very slender (1–1·5 mm. diameter) for the lower four-fifths, then dilated to 4–5 mm. at the throat ; lobes ovate-spathulate, 12–14 mm. long and 5–6 mm. broad, with concolourous nerves, the three lower lobes with a large oblong callus above the throat ; stamens reaching half-way up the limb ; anthers 5 mm. long, dark purple ; filaments of about the same length ; style branches 2–2·5 mm. long, overtopped by the stamens.

Differs from *T. securigera*, Ker, by the yellow colour of the flowers, the very long and slender lower portion of the perianth tube, the larger leaves, and the style shorter than the stamens.

Div. Uniondale: Hills S. of Georgida, 2800 ft., Oct. 1930, *Fourcade* 4394.

LILIACEAE.

Bulbine altissima (Mill.), comb. nov.

Anthericum altissimum, Mill, Gard. Dict., ed. 8, 8 (1768).

A. longiscapum, Jacq., Coll. Suppl., 84 (1796).

Bulbine longiscapa (Jacq.) Willd.

Dipcadi brevifolium (Thunb.), comb. nov.

Hyacinthus brevifolius, Th., Prodr., 63 (1794).

Polemannia hyacinthiflora, Berg., Linn., 1, 250 (1826).

Uropetalon hyacinthoides, Spreng. Syst. 4, Cur. Post, 135 (1827).

Dipcadi hyacinthoides (Spreng.) Baker.

Haworthia monticola, nom. nov.

H. angustifolia, Bak., Fl. Cap., 6, 347 (1896), non Haw. in Phil. Mag., 1825, p. 283.

? *Aloe stenophylla*, Schultes, Syst. Veg., 7, 641 (1829). Salm-Dyk, Aloe, sect. 3, f. 2. Kunth, Enum., 4, 514.

Baker's description of *H. angustifolia* agrees very well with specimens collected in the George and Uniondale divisions (Fourcade 2498, 3606; Mrs. E. F. Ryder 121), but is incompatible with Haworth's original description of *H. angustifolia* and the characters of the section *Reticulatae* in which he places the species. The leaves are described as being patently recurved, lineate, pellucid at the tips and green below. On the contrary, in *H. angustifolia*, Bak., the leaves are erect and straight or incurved, not lineate, dark green above and translucent in the lower half, which is normally buried underground. There is no figure of Haworth's plant among his drawings at Kew, but it is evident that Baker described an entirely different species, to which a new name has to be given. Schultes' specific epithet is negatived by the priority of *H. stenophylla*, Baker. To facilitate the possible future identification of *H. angustifolia*, Haw., Haworth's own description, which is not generally accessible—there is only a typed copy at Kew—is reproduced in the note below.*

* Sectio RETICULATAE, foliis ambienter rosaceovemultifariis mollibus laevibus laete viridibus integris vel obsolete denticulatis; saepe mucronato-aristatis; superne ad lucem plus minus pellucidis reticulatisve; scapo simplici. . . .

Haworthia angustifolia, H. (slender leaved) foliis lorato-attenuatis arcuatim patenti-recurvis perviridibus, apice subcarinatis; carina orisque crebrerrime denticulatum exasperatis. Habitat C.B.S. G.H. 4. Floret Junio, affiniam more.

Obs. H. chlorocanthae, Nob. proxima, at minor, foliis multo angustioribus, patentioribus et longioribus s. 3–4-uncinalibus, subtus convexis, supra planioribus, saepius linea elevata longitudinali centrali; marginalibus denticulis minutissimus, et inarmato oculo vix conspicuis. Published October 1825 (Haworth in Phil. Mag., 1825, p. 283—Extract from the typed copy at Kew).

Lachenalia haarlemensis, sp. nov. [Scilleae].

Affinis *L. unifoliae,* Jacq., sed folio angustiore, periantho gracili et staminibus multo exsertis differt.

Bulb globose, 1·5 cm. in diameter; peduncle, including inflorescence, 25–30 cm. long, coloured and spotted purple. Leaf single, smooth, linear, clasping the base of the stem for 4–6 cm., spotted purple towards the base, as long as the inflorescence or shorter, 3–4 mm. broad. Flowers patent. Raceme 20–40 flowered, 4–8 cm. long; pedicels slender, 1–2 mm. long; bracts minute, sagittate-cuspidate; perianth mauve-pink, campanulate, 6–8 mm. long and 3–4 mm. broad, the inner segments scarcely longer than the outer, spreading a little at the tips. Stamens nearly twice as long as the inner segments.

Differs from *L. unifolia,* Jacq., by the narrower leaf, shorter perianth, and much-exserted stamens.

From Jacquin's figure of *L. unicolor* it differs by the single narrower leaf and the almost equal inner and outer perianth segments.

Div. Uniondale: N. of Haarlem, 12 miles from Avontuur, 2700 ft., Oct. 1930. *Fourcade* 4345.

Lachenalia subspicata, sp. nov. [Scilleae].

Affinis *L. orchioidei,* Ait., a qua foliis multo angustioribus, racemis paucifloris, perianthii segmentis exterioribus brevioribus, et a *L. Youngii,* Bak., pedicellis brevioribus vel obsoletis differt.

Bulb globose, 1 cm. in diameter. Peduncle, including inflorescence, 6–13 cm. long. Leaves 2, linear, glabrous, about one-fourth shorter than the inflorescence and 3–6 mm. broad, clasping the base of the stem for 2·5–5 cm. Raceme subspicate, 1–3 cm. long, 6–12 flowered; flowers patent, sessile or some with pedicels 1 mm. long; bracts small, deltoid; perianth oblong, campanulate, 8–10 mm. long and 3–4 mm. broad, mauve-pink; outer segments about a third shorter than the inner; style a little exserted; stamens just included.

Differs from *L. orchioides,* Ait., by the much narrower leaves, the fewer-flowered racemes, and the shorter outer perianth segments. From *L. Youngii,* Bak., it differs by the shorter or obsolete pedicels.

Div. Humansdorp: Flats Zuur Anys, on road to Kouga, 1500 ft., Sept. 1925, *Fourcade* 3044.

Massonia modesta, sp. nov. [Allieae].

Affinis *M. hirsutae,* Link & Otto, et *M. echinatae,* Linn. f., sed ab ambabus foliorum indumento breviore et parco, bracteis glabris eciliatis differt.

Bulb ovoid, 10–12 mm. in diameter, with brown tunics. Leaves ovate, obtuse, 20–30 mm. long and broad, 6–7 furrowed, clothed with short whitish bristles on the upper surface, glabrous and smooth beneath.

Capitulum sessile, 10–12 mm. in diameter. Outer bracts 15 mm. long and 3–4 mm. broad, oblong-lanceolate, acute, membrane-edged, glabrous, valvate. Outer pedicels 3–4 mm. long. Perianth tube 10 mm. long; lobes obtusely acuminate, reflexed, 7–8 mm. long. Stamens exserted 7–8 mm. above the perianth tube; anthers small, oblong. Flowers white, fragrant.

Near *M. hirsuta*, Link & Otto, et *M. echinata*, L.f., but differs by the shorter and scantier pubescence of the leaves and the glabrous eciliate bracts.

Div. Humansdorp: Karreedouw, 2000 ft., June 1931. Leg. Dr. Jeppe, *Fourcade* 4592.

Ornithogalum capillifolium, sp. nov. [Scilleae].

Affinis *O. tortuoso*, Bak., sed foliis ciliatis paucioribus minus contortis plus capillaribus, staminibus periantho brevioribus differt.

Bulb globose, 6–8 mm. in diameter. Leaves 3–6, filiform, ciliate, straight or spirally twisted, shorter than the peduncle. Peduncle slender, terete, glabrous, 7–13 cm. long. Raceme dense, 8–14 flowered, 15–20 mm. long. Pedicels 3–6 mm. long, ascending. Bracts ovate-acuminate, about half the length of the pedicels. Perianth white, 8–10 mm. long; lobes lightly keeled green or brown. Stamens a little more than half the length of the perianth; filaments lanceolate, subequal. Style as long as the ovary.

Near *O. tortuosum*, Baker, but differs by the ciliate leaves, more capillary, less contorted, and less numerous, and the stamens shorter than the perianth.

Div. Uniondale: Headwaters of the Wagenbooms River, 2000 ft., Nov. 1922, *Fourcade* 2396 (type). On a rocky hill near Groot River in the Long Kloof, March 1814, *Burchell* 4986. Div. Humansdorp: Crevices in bedrock of river, Witte Els Bosch, 750 ft., Dec. 1922, *Fourcade* 2422.

Ornithogalum limosum, sp. nov. [Scilleae].

Affinis *O. Ecklonii*, Schlt., foliis angustioribus pedunculum haud vaginatis, racemis brevioribus, filamentis filiformibus, capsulis plus ellipticis et rostratis differt.

Bulb globose, 8–10 mm. in diameter; outer tunics pale, membranous. Leaves 3–5, linear, erect, glabrous, half the length of the stem or shorter, 3–5 mm. broad. Peduncles 1, or sometimes 2, to a bulb, 18–33 cm. long, terete, glabrous. Flowers 8–25, in an elongating raceme 2–5 cm. long. Lower pedicels 4–8 mm. long, ascending. Bracts lanceolate with setaceous points, the lower up to 16 mm. long, the upper overtopping the buds. Perianth white, membranous, 8–10 mm. long; lobes subequal, narrowly lanceolate, cucullate, lightly keeled with brown near the tips. Stamens subequal, about two-thirds the length of the lobes; filaments filiform in

the upper half, flattened below; anthers elliptical, 1·5 mm. long. Ovary yellowish, elliptical, trilobed, 2·0 mm. long. Style filiform, 3·5 mm. long. Stigma penicillate. Capsule membranous, elliptical, beaked.

Differs from *O. Ecklonii*, Schlt., by the much narrower leaves, not sheathing the peduncle, the shorter racemes, the filiform, not lanceolate, filaments, and the more elliptical and beaked capsule.

Div. Humansdorp: Marshy ground, Witte Els Bosch, 750 ft., Nov. 1920, *Fourcade* 1011 (type); *ibid.*, *Hutchinson* 1410.

Ornithogalum petraeum, sp. nov. [Scilleae].

Affinis *O. niveo*, Ait., sed foliis ciliatis, pedunculis robustioribus, racemis densioribus 8–16 floribus differt.

Bulb globose, 6–12 mm. in diameter. Leaves 6–12, linear, ciliate, 6–24 cm. long and 0·5–1 mm. broad, clasping the base of the stem. Peduncles 1–3 to a bulb, terete, glabrous, 5–13 cm. long. Raceme subcorymbose, densely 8–16 flowered, 12–30 mm. long. Lower pedicels up to 20 mm. long. Bracts ovate-cuspidate, 4–5 mm. long. Perianth white, 8–10 mm. long; lobes obscurely keeled brown, the inner somewhat shorter and narrower. Stamens nearly the length of the perianth; filaments alternately lanceolate and broadly linear. Style the length of the ovary.

Near *O. niveum*, Ait., but differs by the ciliate leaves, stouter peduncles, and the denser 8–16 flowered racemes.

Div. Humansdorp: Kromme River, E. of Assegai Bosch. Flowered in cultivation. *Fourcade* 3940.

MUSACEAE.

Strelitzia augusta, Thunb., Fl. Cap., 216 (1823).

Heliconia alba, L.f., Suppl., 157 (1781).

S. alba (Th.), Druce (1917), non Skeels (1912), N. America.

ORCHIDACEAE.

Acrolophia capensis (Berg.), comb. nov.

Limodorum capense, Berg., Des. Pl. Cap., 347 (1767).

Satyrium triste, L.f., Suppl., 402 (1781).

A. tristis (L.f.), Schltr. & Bolus.

Herschelia lacera (Sw.), comb. nov.

Disa lacera, Sw. in Vet. Acad. Handl. Stockh., 1800, p. 212.

H. venusta, Kränzl., Orch. Gen. & Sp., 1, 805 (1897–98).

Mystacidium capense (L.f.), Schlechter, Orchideen, 597 (1914).

Epidendrum capense, L.f., Suppl., 407 (1781).

M. capense (L.f.), Druce (1917).

M. filicorne, Lindl. in Hook., Comp. Bot. Mag., 2, 206 (1835–36).

Pterygodium catholicum, Sw.

Ophrys alaris, L.f., Suppl., 404 (1781).

P. alare (L.f.), Druce (1917), invalidated by *P. alare* (Th.), Dur. & Sch., Consp. Fl. Afr., 5, 116 (1892) = *Arethusa alaris,* Th. Pr., 3 = *P. platypetalum,* Lindl.

DICOTYLEDONES.

ANACARDIACEAE.

Laurophyllus capensis, Thunb., Prodr., 31 (1794).

L. capensis (Th.), Druce (1917).

APOCYNACEAE.

Carissa cordata (Mill.), comb. nov.

Lycium cordatum, Mill., Gard. Dict., ed. 8, 10 (1768).

C. Arduina, Lam., Encycl., i, 555 (1783).

ASCLEPIADACEAE.

Tylophora cordata (Thunb.), comb. nov.

Apocynum cordatum, Th., Prodr., 47 (1794).

T. syringaefolia, E. Mey., Comm., 198 (1835–37).

CAMPANULACEAE.

Lobelia sylvatica, sp. nov.

Affinis *L. Boivinii,* Sond., sed foliis multo longioribus, petiolis longis, calycis lobis lineari-subulatis differt.

Stems prostrate, sometimes rooting at the nodes, angular, subhirsute. Branches herbaceous, hirsute. Leaves all petioled, ovate, obtuse, narrowing suddenly into the petiole, or subcordate at the base, sinuate or crenato-dentate, thin, finely and appressedly pubescent on both sides, pilose on the nerves beneath, 25–35 mm. long and 16–28 mm. broad. Petioles flat, broader at the apex, 12–16 mm. long. Flowers axillary, solitary. Pedicels 25–50 mm. long, pubescent. Calyx obconical, pubescent, 9–12 mm. long; lobes linear-subulate, longer than the tube. Corolla white, about 20 mm. long, the lower lip with purple markings on the throat, its lobes oblong, rounded or subacute, about 7 mm. long and 2·5 mm. broad, hirsute on back; lobes of the upper lip about 5 mm. long and 1 mm. broad. Anthers bluish-grey, the two lower bearded.

Differs from *L. Boivini,* Sond., by the much larger leaves, the long petioles, and the linear-subulate calyx lobes. From *L. pubescens,* Ait., by the flowers being solitary, not racemose, and the upper leaves being petioled, not sessile.

Div. George: Touws River, in forest, Nov. 1928, *Fourcade* 4114.

Prismatocarpus Rogersii, sp. nov.

Affinis *P. Candolleano,* Ch. & Schl., sed floribus minoribus confertioribus, bracteis membranacioribus cartilagineo-ciliatis lobis purpureo apiculatis, foliis latioribus dentatis differt.

A shrub 30 cm. high, much branched from the base. Branches slender, sprinkled with thick, white hairs. Leaves alternate, quasi-fascicled or solitary, linear, subobtuse, cuspidate, with narrowly revolute margins, otherwise flat, 1–3 dentate on each side, with a few thick, white hairs on the midrib beneath, 15–25 mm. long and 1·5–3 mm. broad. Spikes terminal, few flowered. Lower flowers up to 1 inch distant, upper approximate. Flowers white, sessile, 10–12 mm. long. Bracts membranous, lanceolate, 6–7 mm. long, ciliate, with thick, white hairs, 2–3 dentate on each side, the teeth narrowly deltoid, purple at the tips. Calyx glabrous, 7–10 mm. long; lobes oblong, acuminate, 2·5–3 mm. long. Corolla white, infundibuliform; lobes oblong, rounded or obscurely cuspidate, 3·5 mm. long and 2 mm. broad. Capsule crowned by the persistent calyx, splitting longitudinally. Seeds reniform, muriculate.

Differs from *P. Candolleanus,* Ch. & Schl., by the smaller and more approximate flowers, the membranaceous bracts with purple-tipped lobes, the cartilaginous-ciliate bracts, branches and younger leaves, and the broader and more dentate leaves.

Div. George: Montagu Pass, 2250 ft., June 1927, *Fourcade* 3254 (type); Aug. 1915, *Rogers* 16199; Oct. 1814, *Burchell* 5960. George Mt., Jan. 1897, *Bolus* 8662. Div. Swellendam: Elim, 700 ft., April 1896, *Schlechter* 7670.

Prismatocarpus virgatus, sp. nov.

Affinis *P. Ecklonii,* A. DC., sed bracteis dentatis, et *P. campanuloidei,* Sond., bracteis et calycis lobis brevioribus differt.

Stem virgate, simple, 30–40 cm. high, glabrous, or minutely puberulous at the base. Leaves alternate, erect, linear-lanceolate, acute, with narrowly revolute margins, 1-toothed on each side near the base, glabrous, about 20 mm. long and 3 mm. broad, more crowded and smaller towards the base. Flowers 20–30 mm. long, in a terminal spike 4–11 cm. long, up to 9-flowered, distant below, approximate above. Bracts glabrous, ovate at the base, 15 mm. long and 5 mm. broad, with 2–3 short acute teeth on each side and a terminal acute tooth 9–10 mm. long. Calyx glabrous, with lanceolate acuminate lobes 9–10 mm. long and 2 mm. broad. Corolla white, glabrous; lobes obovate-cuspidate, about 8 mm. long and 5 mm. broad.

Differs from *P. Ecklonii,* A. DC., by the toothed bracts. From *P. campanuloides,* Sond., by the bracts and the much shorter calyx-tube.

Div. Uniondale: 8 miles W. of Avontuur, S. of road to George, Dec. 1930, *Fourcade* 4528.

CELASTRACEAE.

Hartogia capensis, Thunb.

One of the characters of the genus *Hartogia,* Thunb., is that the seed is exendospermous. Examination of numerous fruits of *Hartogia,* however, reveals that the seed possesses a copious white endosperm. Cotyledons bright green. Radicle short, cylindrical, inferior.

Thunberg in his original description (Nov. Gen., 5, 86) says: " Drupa exsucca, ovata, scabriuscula, glabra, magnitudine vix nucis avellanae. Nux disperma, subcarnosa."

De Candolle, Prodr., 2, 12 (1825), has: " Drupa exsucca ovata bilocularis 2-sperma."

Meisner, Plant. Vasc. Gen. (1836–43), has: " Drupa exsucca 2-loc. 2-sp."

Endlicher, Gen. Pl., p. 1088 (1839 or –40), makes the first reference to endosperm: " Embryonis exalbuminosi, orthotropi, cotyledones foliaceae, orbiculatae, radicula brevissima infera." The error he then made has been copied successively by Harvey and Sonder in the Flora Capensis, Bentham and Hooker in the Genera Plantarum, Loesener in Engl., and Prantl, Nat. Pflanzf., and Miss Davison in the latest monograph of the African species of the family.

Gymnosporia, Wight & Arn.

Bentham and Hooker are generally credited with having upheld the genus *Gymnosporia* in the Genera Plantarum, a correction in vol. i, pt. 3, p. 997, reducing the genus to *Celastrus* having been overlooked, or ignored, by later authors:

" 364. 16. Celastrus *adde*:

" Gymnosporia, Wight & Arn., supra, p. 365, cum synonymis ibidem datis ad Celastrum jungenda est. Distinctiones ex ovario cum disco plus minus confluente, v. ex habitu et inflorescentia petitae, in specibus pluribus intermediis evanescunt."

P. 998: " 365. 18. Gymnosporia deleatur, genus uti supra ad Celastrum reducendem."

COMPOSITAE.

Aster outeniquae, sp. nov. [Astereae].

Affinis *A. corymbosae,* comb. nov. (*Mairea corymbosae* Harv.), sed capitulis haud corymbosis, pedunculis bracteatis, foliis et capitulis majoribus differt.

An erect shrub 60 cm. high. Stems glabrous, densely leafy above, naked and sheathed with imbricated leaf scars below. Leaves alternate, linear or oblanceolate, acute, with subrevolute margins, scabrid dentate, broad-based, subdecurrent, at length reflexed, up to 5 cm. long and 9 mm. broad. Peduncles terminal, hairy, 1-headed, bracteated to the head with

several linear, ciliate bracts. Heads large and handsome, radiate, about 40 mm. across, white or a few pink. Involucral bracts about 24, 3-seriate, lanceolate, flat, green with 3 orange veins, silky-ciliolate, the inner 10–12 mm. long and 2–3 mm. broad, the outer shorter. Ray-flowers about 18, the lamina elliptical, about 12 mm. long and 4 mm. broad, entire or minutely 2-dentate. Achenes elliptical, compressed, margined, dark purple, minutely pubescent, about 5 mm. long and 2 mm. broad. Disk achenes fertile. Pappus uniseriate, plumose to the base.

Differs from *Mairea corymbosa*, Harv., by the flowers not being corymbose, the bracteate peduncles, and the larger heads and leaves.

In placing this species in *Aster* rather than in *Mairea*, I follow Professor R. H. Compton who states,* with the approval of Mr. J. Hutchinson, that the genus *Mairea* should be restricted to the species " characterised by a scapose or subscapose inflorescence and leaves mainly radical or basal, and the remainder removed to *Aster* or *Felicia* according to the view taken of the scope of these genera."

Div. Humansdorp: Mountain slopes above forest, Witte Els Bosch, 3000 ft., Sept., *Fourcade* 925 (type). Div. George: Georgetown Mountains, Aug., *Prior* in Herb. Kew.

Aster venustus, sp. nov. [Astereae].

Affinis *A. Pappei*, Harv., sed foliis glabris differt.

A shrub 15–25 cm. high. Branches reddish, glabrous. Leaves alternate, linear-oblanceolate or subspathulate, broad-based, glabrous, subcoriaceous, with revolute margins, the lower up to 20 mm. long and 2·5 mm. broad, longer than the internodes, the upper crowded and much smaller. Peduncles up to 10 cm. long, striate, naked, glandularly scabrid. Heads many-flowered, 25 mm. across when expanded. Involucral bracts 14–16, linear, about 5 mm. long and 1 mm. broad, acute or obtuse, membrane-edged, 3–4 ribbed, glandularly pubescent and with a terminal tuft of hairs. Rays about 16–18, blue, 8–9 mm. long and 2 mm. broad. Disk flowers yellow. Pappus of many serrulate white bristles. Achenes angularly striate, truncate, pubescent in the striae, 1 mm. long.

Near *A. Pappei*, Harv., from which it differs by the leaves being glabrous.

Div. George: Keurbooms River, Long Kloof, above drift, April, *Fourcade* 3818.

Aster Westae, sp. nov. [Astereae].

Affinis *A. echinato*, Less., sed foliis angustioribus et longioribus crebre imbricatis haud reflexis differt.

A virgate shrub 30–40 cm. high, sparingly branched. Branches glabrous, densely covered with erect imbricating leaves. Leaves linear, scarcely

* Trans. Roy. Soc. S. Afr., 1931, vol. xix, p. 312.

tapering to the base, 8–10 mm. long and 1–1·5 mm. broad, acute, concave above, keeled beneath by a prominent midrib, cartilagineo-ciliate, otherwise glabrous. Peduncles terminal, sometimes 2 together, 1-flowered, scarcely nude, white pilose. Involucral bracts lanceolate, acute, about 8 mm. long and 1·5 mm. broad, green with purple tips, cartilagineo-ciliate, the inner scarious. Heads up to 30 mm. in diameter. Rays about 20, 10 mm. long and 2 mm. broad, blue. Disk flowers yellow. Achenes flat, ovate, subacute, margined, appressedly pubescent, at length glabrous, purple-black, about 2·5 mm. long and 1·2 mm. broad. Pappus villous.

Differs from *A. echinatus*, Less., by the narrower and longer leaves, closely imbricated, not reflexed.

Div. Humansdorp: Hoffman's Bush, 800 ft., Oct. 1928, *Fourcade* 4035 (type). Ratels Bosch, 650 ft., Aug., *Fourcade* 50. Zitzikamma, 300 ft., Sept., *Schlechter* 5976. Humansdorp, *Ethel West* 86.

Berkheya barbata (L.f.), Hutch., comb. nov.
Gorteria barbata, L.f., Suppl., 382 (1781).
Rohria carlinoides, Vahl., Act. Soc. H. H. Hafn., 1, 2, (1791).
B. carlinoides, Willd.

Berkheya carduodes (Less.), Hutch., comb. nov.
Stephanocoma carduodes, Less., Syn., 56 (1832).
Stobaea decurrens, Thunb., Fl. Cap., 621 (1823), but specific epithet previously used by Hutch. and Burtt-Davy for *Rohria decurrens*, Th. = *Berkheya carduiformis*, DC.

Berkheya petiolata (DC.), Hutch., comb. nov.
Stobaea petiolata, DC.

Conyza pinnata (L.f.), O. Kze. in Rev. Gen. Pl., 3, 3, 142 (1898).
C. pinnata (L.f.), Druce (1917).
Erigeron pinnatum, L.f., Suppl., 368 (1781).
C. pinnatilobata, DC., Prodr., 5, 387 (1836).

Dicrocephala integrifolia (L.f.), O. Kze.
D. integrifolia (Ait.), O. Kze. (1898).
Hippia integrifolia, L.f., Suppl., 389 (1781); Ait., Hort. Kew., 3, 278 (1789), excl. syn.
Grangea latifolia, Poir. (1811).
D. latifolia, DC.
Ethulia auriculata, Thunb., Pr., 141 (1800).
D. auriculata (Thunb.), Druce (1917).

Gazania subulata, R. Br. in Ait., Hort. Kew., ed. 2, 5, 140 (1813).
Gorteria linearis, Thunb., Fl. Cap., 697 (1823).
G. linearis (Thunb.), Druce (1917).

Helichrysum serpyllifolium, Less.
Gnaphalium serpyllifolium, Berg., Descr. Pl. Cap., 250 (1767).

G. orbiculare, Thunb., Fl. Cap., 659 (1823).
H. orbiculare (Thunb.), Druce (1917).

Hirpicium alienatum (L.f.), Druce.
H. alienatum (Thunb.), Druce (1917).
Oedera alienata, L.f., Suppl., 390 (1781); Thunb., Fl. Cap., 725 (1823).
H. echinulatum, Cass.

Osteospermum decumbens, sp. nov. [Calenduleae].

Affinis *O. ciliato* Berg. sed foliis integris eciliatis differt.

A diffuse, decumbent, trailing shrub, paniculately much branched, the young parts cobwebbed, the older glabrous. Branches angularly winged, smooth; wings purplish. Leaves alternate, sessile, half-clasping, oblanceolate, tapering much to the base, subcoriaceous, entire, with a cartilaginous smooth margin, the lower up to 7 cm. long and 2·5 cm. broad, becoming smaller and much narrower above. Outer involucral bracts linear-lanceolate, acuminate, coarsely hispid, with a thickened smooth cartilaginous margin; inner bracts broader and thinner, densely setose-pilose. Achenes ovoid, terete, smooth, 4 mm. long.

Nearest *O. ciliatum*, Berg., from which it differs by the leaves being entire and eciliate.

Div. Humansdorp: Clarkson, 800 ft., Nov. 1927, *Fourcade* 3500 (type); between Hoffman's Bush and Eerste River, *Britten* 1125. Div. George: Hills near George, *Schlechter* 2426.

Pentzia incana (Thunb.), O. Kze, Rev. Gen. Pl., 3, 3, 166 (1898).
P. incana (Thunb.), Druce (1917).
Chrysanthemum incanum, Thunb., Fl. Cap., 693 (1823).
P. virgata, Less., Syn. Comp., 266 (1832).

Pentzia pilulifera (L.f.), comb. nov.
Cotula pilulifera, L.f., Suppl., 378 (1781).
Matricaria pilulifera (L.f.), Druce.
Cotula globifera, Thunb., Fl. Cap., 696 (1823).
Matricaria globifera, Fenzl.

Peyrousea umbellata (L.f.), comb. nov.
Cotula umbellata, L.f., Suppl., 378 (1781).
P. calycina, DC., Prodr., 6, 76 (1837).

Pteronia teretifolia (Thunb.), comb. nov.
Osteospermum teretifolium, Thunb., Fl. Cap., 713 (1823).
P. baccharoides, Less., Syn. Comp., 196 (1832).

Senecio dissidens, sp. nov. [Senecionideae].

Affinis *S. oxyodonto*, DC., et *S. Zeyheri*, Turcz., sed differt pedunculis ultimis dense bracteatis, foliis penninervis lanceolatis profundius incisis, corymbis multicapitatis, achaeniis glabris.

A robust shrub 1·2–2 m. high, glabrous in all its parts. Branches erect, virgate, terete, striate. Leaves erect, sessile, half-clasping, lanceolate, acute, sharply and unequally toothed and incised, narrowed at the base to the width of the rachis, minutely eared, up to 10 cm. long and 4 cm. broad, with margins narrowly revolute. Corymb branched, many-headed. Heads radiate, about 8 mm. long, on short multibracteated pedicels of the same length, or shorter or longer. Involucre of about 12–14 linear, acuminate bracts, membrane-edged, amply calycled. Disk flowers about 35; rays about 10, yellow, 4-veined, ovate, about 3 mm. long and 1·5 mm. broad. Achenes cylindrical, glabrous, shiny brown, tapering at each end, and crowned by a rim at the truncate apex.

Differs from *S. oxyodontus*, DC., and *S. Zeyheri*, Turcz., by the densely bracteated pedicels, the penninerved, lanceolate, more deeply incised leaves, the many-headed corymb, and the glabrous achenes.

Div. Uniondale: Lower slopes of Zuurberg at Georgida. *Fourcade* 4287.

Senecio dumosus, sp. nov. [Senecionideae].

Affinis *S. dissidenti*, Fourcade, foliis minus incisis axillis et pagina inferiore arachnoideis, acheniis in striis hispidis differt.

A shrub 0·9–1·5 m. high. Branches erect, virgate, terete, striate. Leaves erect, sessile, half-clasping, lanceolate, acute, irregularly toothed, penninerved, eared at the base, glabrate above, more or less cobwebbed beneath and in the axils, about 6–7 cm. long and 1·5–2 cm. broad, with margins narrowly revolute. Corymb branched, many-headed. Heads radiate, about 8 mm. long, on multibracteated pedicels about 8–15 mm. long. Involucre amply calycled, of about 12–14 linear, acuminate, membrane-edged bracts. Disk flowers about 30; rays about 10, yellow, 4-veined, about 5 mm. long and 1·5 mm. broad. Achenes striate, hispid on the striae.

Differs from *S. dissidens*, sp. nov., by the less incised leaves, cobwebbed in their axils and under-surface, and the striate achenes, hispid on the striae.

Div. Uniondale: Avontuur Poort, 4 miles from Uniondale, Dec. 1930, *Fourcade* 4526.

Senecio litorosus, sp. nov. [Senecionideae].

A *S. pellucido* DC., foliis carnosis calloso-denticulatis haud repando-dentatis, disci floribus circiter 80.

Herbaceous, 30–45 cm. high, glabrous in all its parts. Stem branching, striate, fistular. Leaves alternate, oblanceolate, acute, plicato-mucronate, tapering much to the broad base which is more or less eared and ciliate, calloso-denticulate on the recurved margins, fleshy, sometimes with axillary leaf-shoots, varying much in size on different plants, on some up

to 4 cm. long and 8 mm. broad, on others not exceeding 3 cm. long and 3 mm. broad. Corymbs 6–12 headed, on longish peduncles, with a few reduced leaves. Heads about 7 mm. long, borne by bracteate pedicels 5–40 mm. long. Involucre amply calycled, of about 20 linear, acuminate, membrane-edged bracts nearly equalling the head, dark-tipped when mature. Rays 12–14, yellow, 4–5 mm. long. Disk flowers about 80. Achenes terete, tapering a little at each end, rib-striate, glabrous in the type, but pubescent on the striae in No. 1796, 2 mm. long and 0·2 mm. in diameter.

Differs from *S. pellucidus*, DC., in the leaves being fleshy, not membranous, calloso-denticulate, not repand-toothed, and the disk flowers 80, not 12–20.

Div. Humansdorp: Seashore, Eerste River, March 1921, *Fourcade* 1201 (type). Div. Knysna: Banks of Knysna River, near old ford, *Fourcade* 1796.

Senecio othonniformis, nom. nov.

S. paucifolius, DC., Prodr., 6, 403 (1837), non *S. G. Gmelin*, It., 1, 171 (1774).

CONVOLVULACEAE.

Cuscuta alpestris, sp. nov. [§ Pachystigma].

Affinis *C. capensi*, Choisy, a qua cymarum longitudine irregulari, florum capitulis apertis haud globosis, corollae lobis tubo aequilongis, floribus plerumque minoribus, pedunculis communibus gracilioribus differt.

Stems very slender. Flowers in 1–4 flowered, densely clustered cymes of irregular length. Bracteoles 1 mm. long, lanceolate. Pedicels 2–3 times the length of the flower, or longer. Common peduncle up to 30 mm. long. Calyx one-third the length of the corolla, its lobes ovate, acute, shortly united at the base. Corolla white, 3–4 mm. long; lobes ovate-deltoid, obtuse or subacute, not reflexed, about as long as the tube. Stamens not much exceeding the corolla tube; filaments 1–2 times the length of the subglobose, subcordate anthers. Scales obovate, fimbriate, as long as the corolla tube. Styles free to the base, twice as long as the clavate stigmas.

Near *C. capensis*, Choisy, from which it differs by the irregular length of the cymes, making the clusters of flowers open, not globose, by the corolla lobes being only the length of the tube, by the flowers being generally smaller and the common peduncles more slender.

Div. Uniondale: Headwaters of Wagenbooms River, 2000 ft., Nov. 1922. On *Erica decipiens*. *Fourcade* 2389 (type). Div. Knysna: Paardekop, 2000 ft., Oct. 1921. On *E. decipiens*. *Fourcade* 1508.

CRASSULACEAE.

Cotyledon flavida, sp. nov. [§ Paniculateae].

Affinis *C. decussatae*, Sims, habitu robustiore, foliis longioribus et fusiformibus, floribus majoribus lucide flavis, corollae tubo haud urceolato sed fauce latiore quam prope basin, lobis haud reflexis differt.

A robust shrub 0·6–1 m. high, much branched. Leaves opposite, 4-ranked, fleshy, elongate, subterete, shallowly concave above, the younger cuspidate, the older becoming blunt at the apex, glabrous, glossy, dark green, 8–10 mm. in diameter and up to 10–12 cm. long. Peduncles terminal on the branches, corymboso-paniculate, many-flowered, 10–30 cm. long. Flowers nodding, pale yellow; pedicels 8–15 mm. long. Calyx 4–5 mm. long, dehiscing circumscissilely, together with the corolla, from the receptacle on maturity; lobes deltoid, acute, longer than the tube. Corolla about 30 mm. long, dilated from 5–6 mm. diameter at the base to 8–10 mm. at the mouth; lobes ovate, acute, about 12 mm. long and 7 mm. broad, erect. Stamens as long as the corolla, inserted, at about the middle of the corolla tube, in a ring of thickly matted white hairs; anthers globose, subcordate. Styles equalling the stamens, rather thick; stigmas subpeltate. Carpels fusiform, attenuated into the recurved styles, 2–2·5 mm. in diameter, many-seeded. Seeds oblong, about 0·75 mm. long, longitudinally striate.

Near *C. decussata*, Sims, from which it differs by the more robust habit, the longer and less fusiform leaves, the larger flowers, their clear yellow colour, the tube of the corolla not being urceolate but wider at the mouth than near the base, and by the corolla lobes not being reflexed.

Div. Humansdorp: Sand dunes, Slang River, Nov. 1921, *Fourcade* 1869 (type).

Crassula lactea, Ait.

In his "Materials for a Critical Revision of Crassulaceae" (Trans. Roy. Soc. S. Afr., vol. xvii (1929), p. 199) Dr. Schönland quotes a specimen from "sand dunes east of mouth of Keurbooms River, 50 ft., May, *Fourcade* 232. (Fourcade states that the flowers are blue. This, I venture to think, is a slip.)" The slip is not mine, the locality and number being those of a specimen of *Myosotis sylvatica*, Hoffm., in which it is natural enough for the flowers to be blue. *C. lactea* does not grow on sand dunes, but in moist, shady, rocky places. The correct number and locality for my specimen of *C. lactea* are: Division Knysna: Rocky banks of the Keurbooms River, May, *Fourcade* 215. Flowers white.

CRUCIFERAE.

Heliophila cornigera, sp. nov.

Affinis *H. incanae*, Thunb., sed foliis glabris crassioribusque et caulibus glabris differt.

Perennial, suffruticose, more or less decumbent, 30 cm. high, simple or branched, glabrous in all its parts except the sepals. Branches terete, fistular, with prominent leaf scars below. Leaves elliptical-oblong entire, cuspidate-mucronate, fleshy, more or less purple-margined; the lower obtuse, up to 50 mm. long and 17 mm. broad; the upper acute, 20–40 mm. long and 5–8 mm. broad. Flowers in terminal many-flowered elongating racemes. Pedicels 8–16 mm. long, thickened above, more or less decurrent into the winged-striate rachis. Sepals 4–6 mm. long, oblong, openly pilose with long broad-based white hairs, membrane-edged, tipped with a gibbous callus below the apex. Petals blue, orbicular-spathulate, 7 mm. long and 5 mm. broad. Lateral stamens toothed. Anthers oblong, obtuse, 2·5 mm. long. Style cylindrical, 0·8 mm. long. Stigma capitate. Pods 4–8 cm. long and 2·5–3 mm. broad, erect, sessile, linear, compressed, many-seeded, glabrous, tipped with an enlarged compressed ovate-cuspidate style 6–7 mm. long and 1·5–2 mm. broad. Valves 3-nerved. Seeds discoid, winged, 2·5 mm. in diameter.

Differs from *H. incana*, Thunb., by the glabrous and thicker leaves and the glabrous stems.

Div. Humansdorp: Sand dunes, Slang River, Nov. 1921, *Fourcade* 1815A (type). Humansdorp, *Mrs. G. R. Christie*, 49.

CUCURBITACEAE.

Kedrostis angulata (Berg.), comb. nov.

Sicyos angulata, Berg., Descr. Pl. Cap., 352 (1767).
Bryonia triloba, Thunb., Fl. Cap., 34 (1823).
Coniandra Thunbergii, Sond., Fl. Cap.
K. nana, Cogn.
K. triloba (Thunb.), Druce.

Kedrostis Zeyheri, Cogn.

Coniandra Zeyheri, Schrad. in E. & Z., Enum., 275; and *Cyrtonema sphenoloba*, Schrad., *ibid.*, 276 (1836).
K. sphenoloba (Schrad.), Druce.

GERANIACEAE.

Pelargonium gracillimum, sp. nov. [§ Hoarea].

Affinis *P. luteolo*, N. E. Br., ovario hirsuto, florum colore roseo differt.

Stemless perennial 10–15 cm. high, with ovoid tuberous rootstock 20 by 10 mm., and crustaceous, brown, exfoliating tunics. Leaves produced after the flowers, on long appressed-setulose petioles, bi-tripinnatipartite; pinnae 3–5, the upper 3 together, the lower pair, when present, about 8 mm. distant; ultimate laciniae divaricate, linear, narrowly oblanceolate

or spathulate, from 12–15 mm. long and 1 mm. broad to 27 mm. long and 3·5 mm. broad, about 13–14 in total number; petioles 40–50 mm. long, 0·4 mm. in diameter. Scapes simple or once-branched, appressed pubescent; umbels 4–6 flowered. Bracts deltoid-acuminate, appressed pubescent, 3 mm. long. Pedicels setulose, 15–25 mm. long. Sepals about 5 mm. long, acute, soon reflexed, brown with white scarious margins. Petals 5, narrowly spathulate, clawed, 10 mm. long and 3 mm. broad, rosy-white with carmine veins from the claws. Stamens 4, 3–4 mm. long. Anthers ovoid, yellow, 1·3 mm. long. Ovary densely hirsute. Style purple, 1·5 mm. long, 5-branched, the branches 1 mm. long.

Nearest *P. luteolum*, N. E. Br., from which it differs by the hirsute ovary and the colour of the flowers.

Div. Uniondale: Hills N. of Avontuur, 2800 ft., Jan. 1928. Leaves produced in cultivation. *Fourcade* 3570.

Pelargonium humansdorpense, R. Knuth, vice *P. hermansdorpense*, R. Knuth, by orthographical error, in Fedde's Repert., 28, 90 (1930). Type: *Fourcade* 3559 (Div. Humansdorp).

Pelargonium mollicomum, sp. nov. [§ Cortusina].

A *P. odoratissimo*, Ait., differt foliorum indumento crassiore, stipulis ciliatis membranaceis, calycis lobis linearibus, floribus multo longioribus.

30–50 cm. high. Stem short and succulent, rough with persistent stipules. Branches herbaceous, weak. Cauline leaves on hairy petioles up to 70 mm. long. Leaves roundish cordate, very obtuse, repando-lobulate, irregularly doubly dentato-crenulate, palmately nerved, pubescent mainly on the nerves and the margins, up to 35 mm. long and 45 mm. broad. Stipules deltoid, membranous, whitish, ciliate. Peduncles mostly terminal, up to 10 cm. long, 3–6 flowered. Pedicels 15–25 mm. long, glandular, and pilose with coarse white hairs. Sepals linear-lanceolate, acute, 6–7 mm. long, setulose, with 2–3 brown veins and a white margin. Petals white, veined purple from the claw; the two upper much longer, 16–20 mm. long and 5 mm. broad, rounded, entire; the three lower 8–10 mm. long and 2–2·5 mm. broad. Stamens 7, subequal; filaments purple. Ovary densely hirsute. Style 4–7 mm. long, 5-branched, purple.

Differs from *P. odoratissimum*, Ait., in the much coarser pubescence of the leaves, the ciliate membranous stipules, the linear calyx-lobes, and the much longer flowers.

Div. Humansdorp: Cambria, Oct. 1923, *Fourcade* 2737 (type). Hills near Hankey, *Fourcade* 2765.

LEGUMINOSAE.

Cyclopia aurea, sp. nov. [Podalyrieae].

Affinis *C. subternatae*, Vogel, sed calycis lobis obtusis dorso rotundatis, bracteis obtusis coriaceis differt.

A glabrous shrub 0·5–0·7 m. high. Twigs angular, metallic golden yellow. Leaflets borne on a thick decurrent shield which is ciliate within, linear-cuneate, plicato-mucronulate, with revolute margins, 16–30 mm. long and 2·5–6 mm. broad. Bracts 2, concave, ovate, obtuse, mucronately keeled at the apex, coriaceous, ciliate, densely hirsute within, 3–4 mm. long and 4–5 mm. broad. Flowers terminal and axillary near the ends of the branches, yellow. Pedicels 6–7 mm. long. Calyx strongly intruse, its lobes subequal, ovate or deltoid, round-backed, obtuse, with woolly margins, sparsely hairy within, 2–3 mm. long, one-half the length of the tube. Carina falcate, acute, 10–12 mm. long. Vexillum 12–16 mm. broad.

Differs from *C. subternata*, Vogel, by its obtuse round-backed calyx lobes and the coriaceous obtuse bracts. Known as the " Kouga Bush Tea " and esteemed much superior to the " Bush Tea " prepared from *C. subternata* growing farther south.

Div. Humansdorp: N. slopes of Zuur Anys hills, W. of de Jager's farm, 1800 ft., Sept. 1925, *Fourcade* 3049 (type); Doorn Kraal, 800 ft., Sept., *Fourcade* 766.

Indigofera glabella, sp. nov. [Galegeae].

Affinis *I. Zeyheri*, Spreng., differt foliolis omnino glabris acutis.

A shrub 0·6–0·9 m. high. Branches erect, reddish, rib-striate, sparsely strigillose, leafy. Leaves subsessile, erect, 4-jugate, 10–15 mm. long; leaflets linear, acute, complicate, recurvo-mucronulate, quite glabrous, 10 mm. long and 0·5 mm. broad. Stipules subulate, 1–2 mm. long. Racemes axillary, on slender glabrous peduncles, 3–4 cm. long to the base of the inflorescence, laxly 6–8 flowered. Bracts ovate-acuminate, 0·5 mm. long. Lower pedicels 4–5 mm. long. Flowers brick-red, 4–5 mm. long; calyx sparsely villous, at first ribbed, 2–2·5 mm. long, its subulate lobes longer than the tube; petals fulvo-sericeous, the vexillum at first brown-black in the bud. Legume (immature) straight, compressed, dark brown, acute, thinly canescent.

Near *I. Zeyheri*, Sprengel, from which it differs by the quite glabrous and more acute leaflets.

Div. Humansdorp: Geelhoulboom River, 400 ft., July 1922, *Fourcade* 2220.

Indigofera grisophylla, sp. nov. [Galegeae].

Affinis *I. stenophyllae*, E. & Z., sed foliolis latioribus et longioribus canescenti-strigillosis differt.

A virgate shrub 0·3 m. high. Branches ribbed, finely strigose. Leaves on short petioles 1–1·5 mm. long, trifoliolate; leaflets linear-oblong, subspathulate, narrowed to the base, obtuse or subacute, with revolute margins and a salient midrib, strigillose on the upper surface and canescent-strigillose on the lower, up to 2·5 cm. long and 4 mm. broad, smaller on

terminal twigs. Stipules toothlike or obsolete. Racemes axillary, subsessile, shorter than the leaf, densely 10–15 flowered. Lower pedicels 4–6 mm. long, strigillose. Flowers 7–8 mm. long, rose-purple. Calyx subacutely based, canescent-strigillose, with a tube about 1·5 mm. long and deltoid lobes of the same length. Petals silky-canescent on their outer surfaces. Legumes (immature) straight, terete, glabrous.

Differs from *I. stenophylla*, E. & Z., by the broader and longer canescent-strigillose obtuse leaves and the more densely (10–15) flowered racemes.

Div. Humansdorp: Otterford, 1300 ft., Mar. 1928, *Fourcade* 3669.

Indigofera Pappei, sp. nov. [Galegeae].

Affinis *I. sulcatae*, DC., sed foliolis subcomplicatis marginibus haud revolutis, leguminibus canescentibus et haud glabris differt.

A shrub 0·3–0·6 m. high, erect, densely branched. Branches and twigs dark brown, angularly furrowed, thinly strigillose. Leaves subsessile, digitately 5-foliolate; leaflets linear, cuneate, subcomplicate, acute, re curved at the apex, strigillose on both surfaces, 5–12 mm. long and 1 mm. broad, strongly midribbed. Stipules minute, toothlike. Racemes subsessile, longer than the leaves, loosely 3–5 flowered. Bracts minute, persistent. Pedicels about 1 mm. long. Flowers purple, 6–7 mm. long. Calyx canescent, its lobes broadly subulate, equalling the tube. Petals canescent. Legumes canescent, terete, acute, terminated by the persistent style, 6–10 seeded, 10–12 mm. long and 1–1·5 mm. in diameter.

Near *I. sulcata*, DC., from which it differs by the leaflets being subcomplicate, not with revolute margins, and by the legumes being canescent, not glabrous.

Div. Humansdorp: Zitzikamma, *Pappe* 41, p.pte. Flats, Rob Hoek, 650 ft., Aug. 1921, *Fourcade* 1383 (type); Ratelsbosch, Aug., *Fourcade* 21, 41. Div. Uniondale: N. side of Blaauw Bosch Pass, 2000 ft., May, *Fourcade* 2995.

Indigofera rhodantha, sp. nov. [Galegeae].

Affinis *I. flabellatae*, Harv., foliorum marginibus revolutis, indumento lanato haud strigoso, cálycis lobis setaceo-acuminatis differt.

A virgate shrub 0·3 m. high. Branches terete. Twigs clothed with coarse glandular brown hairs interspersed in the younger parts with a white tomentum. Leaves on hairy petioles 1 mm. long, digitately 5-foliolate; leaflets linear-cuneate, cuspidately mucronate, with revolute margins, sulcate, minutely foveolate and finely hairy above, woolly-tomentose under, 10–12 mm. long and 1–2 mm. broad. Stipules broadly setaceous, hairy, a little longer than the petiole. Racemes terminal and axillary, equal to or longer than the leaves, 3–6 flowered. Bracts setaceous, 3 mm. long. Pedicels 2 mm. long. Flowers rose-purple, 6–7 mm. long. Calyx densely pubescent; its lobes setaceously acuminate, longer than the

tube. Petals canescent. Legumes (immature) matted with a thick, white tomentum, terete, short, tapering from low down to the persistent style, 2–3 seeded.

Differs from *I. flabellata*, Harv., by the revolute margins of the leaflets, by the woolly, not strigose, pubescence, and by the setaceously acuminate calyx lobes.

Div. Knysna: Yzer Nek, 1800 ft., Mar. 1922, *Fourcade* 2049 (type); mountain veld, Karatera, 1600 ft., Dec. 1922, *Keet* 1155.

Lotononis pumila, E. & Z., Enum., 178 (Jan. 1836).

L. erubescens (E. Mey.), Druce (1917).

Lipozygis erubescens, E. Mey., Comm., 65 (Feb. 1836).

For priority, see Schlt. in Linn., 14, 706 (1841), and Benth. in Lond. Journ. Bot., 2, 426 (1843).

Priestleya angustifolia, E. & Z.

P. villosa (Thunb.), Druce (1917), non DC., Prodr., 2, 122 (1821).

Psoralea heterosepala, sp. nov. [Galegeae].

Affinis *P. obliquae*, E. Mey., et *P. polyphyllae*, E. & Z., ab illa calycis segmento carinali latiore et obtusiore ceteris multo longiore, petiolis brevioribus, innovationum indumento tenuiore, foliolis angustioribus, bracteis ovatis striatis, ab hac etiam calycis segmento carinali et foliolis latioribus differt.

A shrub 1·8–2·5 m. high. Branches puberulous. Leaves 3-foliolate, the younger thinly villous and ciliate, the older glabrescent. Petioles 1 mm. long or less. Leaflets gland-dotted, the medial one obovate-cuneate, 10–15 mm. long and 3–6 mm. broad, the lateral ones rather shorter, very unequal sided, rounded on the outer side at base; midribs prominent, excurrent into recurved mucros 1 mm. long or less. Bracts ovate, 2–3 mm. long, scarious, striate, ciliate. Pedicels axillary, generally 3 together, 1 mm. long. Calyx ribbed, villous or glabrate; its lobes ciliate, the upper 4 deltoid-lanceolate, 2 mm. long, equalling the tube, the carinal one ovate-cuspidate, 6–8 mm. long and 4–5 mm. broad. Flowers blue, 8–10 mm. long, the petals glabrous, veined.

Near *P. obliqua*, E. Mey., from which it differs by the broader and blunter carinal calyx lobe, much larger than the others, the much shorter petioles, the lighter pubescence of the younger parts, the narrower leaflets, and the striate, ovate bracts. From *P. polyphylla*, E. & Z., it differs also by the carinal calyx lobe and the broader leaves.

Div. Humansdorp: The Heights, 1300 ft., Dec. 1928, *Fourcade* 4225 (type); Humansdorp, *Ethel West* 91; Clarkson, *Galpin* 3961, p.pte.

Rhynchosia adenodes, E. & Z., Enum., No. 1676 (Jan. 1836).

Copisma effusum, E. Mey., Comm., 135 (Feb. 1836).

R. effusum (E. Mey.), Druce (1917).

Vigna debilis, sp. nov. [Phaseoleae].

Affinis *V. capensi*, Thunb., sed foliolis subhastatis, floribus minoribus, calycis lobis tubo brevioribus differt.

A prostrate herb, branching from the base. Branches, petioles, and peduncles glabrous, or with a few patent hairs. Leaves pinnately trifoliolate, the terminal leaflet distant; petioles 3–16 mm. long, prolonged 3–10 mm. beyond the insertion of the lateral leaflets; petiolules 1–1·5 mm. long; leaflets linear, subhastate, acute, or subobtuse, mucronulate, with the midrib prominent, glabrous, or the younger sparsely ciliate; terminal leaflet 15–25 mm. long, 1·5–3 mm. broad at the middle and 2–6 mm. at the base; lateral leaflets of about the same length and breadth, unequal sided at the base. Stipules lanceolate from a broad base, acute, ribbed, 2 mm. long; stipellae linear, cuspidate, 1·5 mm. long. Peduncles 35–65 mm. long, 2-flowered at the summit; pedicels 5–8 mm. long. Bracts ovate, acute, 1 mm. long. Calyx campanulate, its lobes ovate-deltoid, subobtuse, 1 mm. long or less, minutely ciliate; tube 2 mm. long and 2–3 mm. broad. Carina herbaceous, broadly ovato-falcate, obtuse, 7–8 mm. long. Alae 10 mm. long, spurred. Vexillum broad, patent, with 2 callous processes within the base, dark purple like the alae. Claws veined yellow.

Near *V. capensis*, Thunb., from which it differs by the subhastate leaflets, the smaller flowers, and the calyx lobes shorter than the tube.

Div. Humansdorp: In turf, Gamtoos River, near Hankey, 150 ft., May 1923, *Fourcade* 2580.

Vigna luteola, Benth., Fl. Braz., 24, 194 (1859–62).

V. repens (L.), O. Kze. (1891), non Bak. in Hook. f. Fl. of Br. Ind., 2, 205 (1878).

PLANTAGINACEAE.

Plantago litoraria, sp. nov.

Affinis *P. carnosae*, Lam., et *P. maritimae*, Lam., ab illa bractearum et sepalorum marginibus eciliatis, corollae lobis obtusis, filamentis et stylis longioribus, foliis lineari-fusiformibus succulentis, ab hac foliis angustioribus vix glabris differt.

Rootstock woody, more or less woolly in the axils of the leaves. Leaves up to 12 cm. long and 3–8 mm. in diameter, fleshy, entire, linear-fusiform, obtuse or obtusely cuspidate, sparsely hairy, mostly on the margins, sessile. Peduncles erect, appressed hairy, subterete, up to 18 cm. long and 3 mm. in diameter. Spikes 3–10 cm. long, cylindrical, dense. Bracts 2–2·5 mm. long, broadly ovate, rounded, with membranous eciliate margins, not keeled, brown. Sepals 2 mm. long, ovate, obtuse, with membranous

margins, smooth or keeled, with a more or less fimbriate membranous wing, glabrous. Corolla tube 1·5–2 mm. long, hairy outside; lobes 1·5 mm. long, ovate, obtuse, deflexed. Filaments 3–4 mm. long, capillary. Anthers 2 mm. long, shortly apiculate. Style 4–5 mm. long. Capsule 3 mm. long, ovoid-oblong, subacute, beaked by the remains of the style, circumscissile below the middle. Seeds oblong, angularly compressed, black.

Differs from *P. carnosa*, Lam., by the eciliate margins of the bracts and sepals, the obtuse corolla lobes, the longer filaments and style, and the linear-fusiform succulent leaves. From *P. maritima*, Lam., by the narrower leaves and their being not quite glabrous.

Div. Humansdorp: Seashore, Eerste River, Jan. 1922, *Fourcade* 1961 (type). Div. Port Elizabeth: Cape Receife, *Burchell* 4391. Div. East London: Seashore, *Galpin* 2809. Div. Cape: Camps Bay, *Prior*.

PROTEACEAE.

Leucadendron album (Thunb.), comb. nov.
Protea alba, Thunb., Diss. Prot., 31 (1781).
L. aurantiacum, Buek, ex Meisn. in DC., Prodr., 14, 217 (1856).

Leucadendron laureolum (Lam.), comb. nov.
Protea laureola, Lam., Ill., i, 234 (1791).
L. decorum, R. Br., Tr. L. Soc., 10, 58 (1810).

Leucospermum cordifolium (Knight), comb. nov.
Leucadendron cordifolium, Knight, Prot., 55 (1809).
L. nutans, R. Br., Tr. L. Soc., 10, 98 (1810).

Leucospermum phyllanthifolium (Knight), comb. nov.
Leucadendron phyllanthifolium, Knight, Prot., 55 (1809).
L. attenuatum, R. Br., Tr. L. Soc., 10, 96 (1810).

Panoramus reflexus (Phill. & Hutch.), comb. nov.
Nivenia reflexa, Phill. & Hutch.

Protea eximia (Knight), comb. nov.
Erodendrum eximium, Knight, Prot., 41 (1809).
P. latifolia, R. Br., Tr. L. S., 10, 75 (1810).

Protea lorifolia (Knight), comb. nov.
Erodendrum lorifolium, Knight, Prot., 41 (1809).
P. macrophylla, R. Br., Tr. L. S., 10, 78 (1810).

RAFFLESIACEAE.

Cytinus sanguineus (Thunb.), comb. nov.
Phelypaea sanguinea, Thunb., Prodr., 1 (1794).
C. dioicus, Juss., Ann. Mus. Par., 12, 443 (1808).

RHAMNACEAE.

Scutia myrtina, Kurz.

Rhamnus myrtinus, Burm., Fl. Ind., 60 (1768).

R. circumcissus, L.f., Suppl., 152 (1781).

S. Commersoni, Brongn., Ann. Sc. Nat. Ser., 1, x, 363 (1827).

S. circumcissa (L.f.), Druce (1917).

RUTACEAE.

Agathosma cryptocarpa, sp. nov. [§ Barosmopetalae].

Ab *A. acutissima*, Dümmer, foliis puberulis ; ab *A. phylicodei*, Fourcade, foliis pedicellis et calycibus puberulis, ovaris pubescenti, disco calycis fauce operto differt.

A shrub 0·3–0·4 m. high, much branched. Twigs shortly and finely pilose. Leaves patent, linear-lanceolate, acuminately subulate, rounded at the base, incurved, convex above, minutely and shortly pilose, with gland-dotted revolute margins, 6–8 mm. long and 1·5 mm. broad. Petioles 0·5–1 mm. long. Flowers white, in 8–10 flowered terminal umbels. Bracts linear, acute, 1 mm. long. Pedicels 1·5–2 mm. long, minutely puberulous. Calyx puberulous, 3 mm. long, closed at the throat by a disk perforated by the style ; calyx lobes subequal, acute, 3 times the length of the tube. Petals 3–4 mm. long and 1–1·5 mm. broad, ovate, shortly clawed, glabrous. Stamens the length of the petals or a little longer ; anthers narrow-oblong, truncate, 0·7 mm. long ; staminodes 2 mm. long, lanceolate, shortly pilose or glabrate, tipped with a reddish gland. Ovary globose, 0·7 mm. long, 3-celled, with 3 short hairy horns. Style glabrous, tapering from the base, about 5 mm. long ; stigma minute, capitate.

Differs from *A. acutissima*, Dümmer, by the puberulous leaves ; from *A. phylicoides*, sp. nov., *infra*, by the puberulous leaves, pedicels, and calyx, the hairy ovary, and the disk closing the calyx throat. By this last character it approaches *Macrostylis*, but the style is entirely different.

Div. Humansdorp : Hills on road to Loerie, 3 miles from Hankey, 400 ft., Mar. 1928, *Fourcade* 3638.

Agathosma phylicoides, sp. nov. [§ Barosmopetalae].

Affinis *A. acutissimae*, Dümmer, sed ramulis pedicellis et calycibus glabris, inflorescentia sub-capitata differt.

A shrub 0·3–0·4 m. high, much branched, glabrous, or on some twigs slightly puberulous. Leaves patent, linear-lanceolate, acuminately subulate, rounded or subcordate at the base, incurved, convex above, with gland-dotted revolute margins, 8–10 mm. long and 1·5 mm. broad. Petioles 1 mm. long, articulated at the base to a decurrent leaf cushion. Flowers white, in 8–12 flowered terminal subcapitate umbels. Bracts linear, acute,

1 mm. long. Pedicels 2–3 mm. long. Calyx 3–4 mm. long, its lobes leafy, lanceolate, acuminately subulate, twice as long as the tube. Petals 4–5 mm. long, obovate-cuneate, scarcely clawed. Stamens as long as or a little longer than the petals; anthers ovoid, 0·7 mm. long; staminodes lanceolate, minutely ciliolate, gland-tipped, 1·5–2 mm. long. Ovary glabrous, 3-locular, 0·5 mm. long. Style glabrous, 3 mm. long; stigma simple.

Near *A. acutissima*, Dümmer, but differs by the twigs, pedicel, and calyx being glabrous, and the subcapitate inflorescence.

Div. Humansdorp: Hills on road to Loerie, 3 miles from Hankey, 400 ft., Mar. 1928, *Fourcade* 3638*a*.

Agathosma puberula (Steud.), comb. nov.

Diosma puberula, Steud., Flora, 1830, p. 548.

Hartogia puberula (Steud.), O. Kze.

A. gnioides, Schlt., Linn., 6, 206 (1831).

Barosma unicarpellata, sp. nov. [Diosmeae].

Affinis *B. scopariae*, Bartl. & Wendl., sed foliis acutis, calycis lobis acutis et ciliatis, ovario monocarpico disco induto differt.

A shrub 0·6–0·9 m. high, much branched. Branches glabrous. Twigs minutely hairy. Leaves alternate, ovate-lanceolate, acute, midribbed, with a thickened recurved margin more or less glandularly crenate, dotted with a few glands beneath, glabrous. Flowers white to rosy, terminal or axillary, subsessile, solitary or in pairs. Bracts minute, ovate, ciliate. Calyx 2–2·5 mm. long, with a disk of connate glands closing over the ovary and perforated by the style; lobes 5, sharply keeled, acute, ciliate. Petals obovate-cuneate, scarcely clawed, densely hairy on the upper surface and glabrous on the back, 5 mm. long and 2–2·5 mm. broad. Stamens 5, the length of the petals; filaments glabrous; staminodes ovoid-spathulate, ciliate, 1 mm. long. Ovary 1-celled, 1-ovuled, turbinate-truncate, glabrous, 0·6 mm. in diameter and height. Style the length of the petals, glabrous; stigma filiform. Fruit oblong, glabrous, 8–9 mm. long, formed of a single compressed carpel opening laterally and ended by a horn about a third of the length of the whole follicle. Seed solitary, reniform, black, shining, 3–4 mm. long.

Differs from *B. scoparia*, which it resembles in appearance, by the acute leaves, the acute, ciliate, calyx lobes, the single carpel of the ovary, and the disk the ovary is covered by.

Has the habit of a *Barosma*, the disk closing over the ovary, perforated by the style, of *Macrostylis*, and the single uniovuled carpel of *Empleurum*.

Div. Humansdorp: Humansdorp-Hankey road, 5 miles, 1200 ft., July 1922, *Fourcade* 2235.

SAPINDACEAE.

Allophyllus spicatus (Thunb.), comb. nov.

Rhus spicata, Thunb., Prodr., 47 (1794).

Schmidelia spicata (Thunb.), Druce.

S. decipiens, Arn., in Hook. Journ., 3, 153 (1841).

SCROPHULARIACEAE.

Sutera atrocaerulea, sp. nov.

Affinis *S. pedunculatae*, Hiern., sed pedicellis multo brevioribus, floribus semper atrocaeruleis differt.

A shrub 0·3–0·6 m. high. Branchlets erecto-patent, subdistichous, glandular puberulous, leafy, grey-green. Leaves alternate, fasciculate, glandular, thick, cuneate, plicate, shallowly 2–3 excise-dentate at the apex, or a few entire, 2–5 mm. long and 0·5–1 mm. broad. Flowers axillary or in terminal leafy racemes, rich dark purplish blue. Pedicels 3–6 mm. long, slender, minutely glandular, 1-flowered, ebracteate. Calyx glandular, 2–3 mm. long, 5-lobed to within 0·5 mm. of the base; lobes lanceolate-linear, acute, somewhat elongating in fruit. Corolla tube 8–11 mm. long, cylindrical, a little dilated and curved below the throat, pubescent outside with comparatively long gland-tipped hairs; limb spreading; lobes oblong, rounded, or sometimes retuse, 4–5 mm. long, minutely glandular on back. Stamens included; anthers ellipsoid, all fertile; filaments sparsely hairy. Ovary glandular-papillose or subglabrous. Style glabrous, about 6 mm. long; stigma cylindrical. Capsule ovoid-conical, minutely glandular, 4–5 mm. long, smooth, or the valves after dehiscence transversely corrugated.

Differs from *S. pedunculata*, Hiern., by the much shorter pedicels and the constantly very dark flowers, never white.*

Div. Humansdorp: Hills 5 miles N. of Humansdorp, 1500 ft., July 1922, *Fourcade* 2224 (type); Keur Kloof, near Kouga, Dec. 1927, *Fourcade* 3568.

var. latifolia.

A typo differt foliis latioribus.

Leaves obovate-cuneate, obtuse, shortly petiolate, 3–7 excise-dentate in the upper half, minutely glandular, up to 4 mm. long and 3 mm. broad. Pedicels 4–9 mm. long. Stigma conical, truncate. Otherwise as in type.

Differs also from *S. pedunculata*, Hiern., by the colour of the flowers and the shorter pedicels, and from the type by the broader leaves.

* Is readily known from all the other species of *Sutera* in the region by its much darker flowers. The inappropriately-named *S. atropurpurea*, Hiern. (*Lyperia crocea*, Eckl.), of Karroo parts, has yellow flowers, which, like those of many other species of *Sutera*, turn black in drying. The type in Herb. Banks "Prom. Bon. Spei, F. Masson," agrees with Ecklon 850 from Fort Beaufort and Bolus 16379 from Graaf Reinet, with which it was compared, except that the flowers (28 mm.) are rather longer.

Div. Humansdorp: Groot Hoek, 600 ft., Sept. 1911, *Fourcade* 739 (type of variety); Malbaars Kraal, 1200 ft., Sept. 1909, *Fourcade* 418.

SOLANACEAE.

Solanum MacOwani, sp. nov.

Affinis *S. acutissimo*, Jacq., sed ramis foliis infra glabris, lobis integris, floribus geminatus differt.

A shrub 1·2–1·8 m. high, bearing long, straight subulate spines on all its parts. Branches glabrous. Leaves ovate, cordate at base, up to 18 cm. long and 15 cm. broad, irregularly lobed, pilose above, glabrous under; lobes obtuse or subacute, mostly entire. Petioles up to 6 cm. long. Flowers usually 2 together. Pedicels 12–15 mm. long. Calyx tube cup-shaped; lobes narrowly deltoid, acute. Corolla 10–12 mm. long, white; lobes ovate, acuminate, 5 mm. broad. Filaments very short; anthers 5 mm. long, tapering to the apex from a base 1·5 mm. broad, dehiscing by 2 terminal pores. Style 6–7 mm. long; stigma ovoid, sulcate. Fruit globose, 25 mm. in diameter, at first green, variegated with darker bands and a white apex, finally tomato-red.

Near *S. acutissimum*, Jacq., from which it differs by the branches and the lower surface of the leaves being glabrous, by the entire leaf lobes, and by the flowers being geminate.

Div. Humansdorp: Storms River, in forest, 700 ft., April 1921, *Fourcade* 1224 (type). Div. Somerset East: *MacOwan* 1493.

STERCULIACEAE.

Hermannia lacera (E. Mey.), comb. nov.

Mahernia lacera, E. Mey. ex Harv., Fl. Cap., 1, 214 (1859–60).

M. scabra, E. & Z., Enum., 398 (1834).

H. scabra, Hochr. in Ann. Cons. & Jard. Bot. Gen., 11 and 12, 3 (1907); non Cavan., Diss., 33, t. 182, f. 2 (1785), nec Jacq., Hort. Schoenb., i, 68, t. 127 (1797).

THYMELAEACEAE.

Lachnaea glomerata, sp. nov. [Euthymelaeaceae].

Affinis *L. Burchellii*, Meisn., sed foliis concavis, capitulis axillaribus, calycis tubo pubescenti et stigmate globoso differt.

A dwarf shrub 0·2 m. high, branched from the base. Branches appressed pubescent. Leaves opposite, linear-lanceolate, acute, concave, glabrous, 6–10 mm. long and 1·5–2 mm. broad. Flowers white, in bracteated 5–8 flowered glomerules borne in the axils of the upper leaves for 25–50 mm. down the branches. Bracts 4–8, ovate-cuspidate, keeled, 2–3 mm. long and broad. Calyx tube hairy, constricted above, 2–3 mm. long; lobes 4,

ovate, obtuse, 3 mm. long and 2 mm. broad, hairy on both surfaces; scales in the hairy calyx throat 8, fleshy, ovoid, 0·1–0·2 mm. in diameter. Stamens 8, those opposite the calyx lobes four-fifths the length of the lobes, those alternate half the length of the lobes. Anthers minute, 0·2 mm. long, ovoid. Style lateral, obconical, hairy, exserted, 2 mm. long. Stigma globose, dark red, penicillate, 0·5 mm. in diameter.

Differs from *L. Burchellii*, Meisn., by the concave leaves, the axillary heads, the hairy calyx tube, and the globose stigma.

Div. Humansdorp: Klein Hoek, 1000 ft., Sept. 1909, *Fourcade* 445.

ON THE EXISTENCE OF A COMMON INTEGRATING FACTOR FOR A SYSTEM OF FIRST ORDER DIFFERENTIAL EQUATIONS.

By F. UNDERWOOD.

(Communicated by Professor J. P. DALTON.)

1. In two recent papers * J. P. Dalton has considered the integration of the differential equation

$$(P_1 + P_2)dx + (Q_1 + Q_2)dy = 0,$$

where P_1, P_2, Q_1, Q_2 are functions of x and y continuous in both variables in the domain under consideration.

His first method † depends upon the possibility of obtaining an integrating factor common to both the differentials $P_1dx + Q_1dy$ and $P_2dx + Q_2dy$. This leads naturally to an inquiry as to whether any such common integrating factor can exist for the system of equations

$$P_rdx + Q_rdy = 0, \quad (r = 1, 2, 3, \ldots m), \qquad . \qquad . \qquad (r)$$

and then to the same inquiry for the more general system

$$P_{s1}dx_1 + P_{s2}dx_2 + \ldots + P_{sn}dx_n = 0, \qquad . \qquad . \qquad (s)$$

$(s = 1, 2, \ldots m; \quad n \geqslant 3; \quad m$ any positive integer).

2. Consider first the system of equations (r), taking only $r = 1, 2, 3$.

Let

$$D_r = \frac{\partial P_r}{\partial y} - \frac{\partial Q_r}{\partial x}, \quad (r = 1, 2, 3).$$

Let ‡

$$A_{rs} = \begin{vmatrix} P_r & Q_r \\ P_s & Q_s \end{vmatrix}; \qquad B_{rs} = \begin{vmatrix} P_r & D_r \\ P_s & D_s \end{vmatrix}; \qquad C_{rs} = \begin{vmatrix} Q_r & D_r \\ Q_s & D_s \end{vmatrix};$$

* (1) "On the Integration of a Certain Type of First Order Differential Equation," American Mathematical Monthly, vol. xxxv, No. 4, April 1928. (2) "On Integrating Factors and Jacobi's Equation," Trans. Roy. Soc. S. Afr., vol. xviii, pt. iv, 1930.

† Dalton's second method in (1) (which will not be discussed in the present paper) may also be found (with one simple example) in Cours d'Analyse, by E. Goursat, tome ii, 4th ed., 1925, Art. 373.

‡ The notation here involves a slight modification of that used by Dalton, but is more convenient for the general systems considered.

and let

$$\Delta = \begin{vmatrix} P_1 & P_2 & P_3 \\ Q_1 & Q_2 & Q_3 \\ D_1 & D_2 & D_3 \end{vmatrix}.$$

If possible, let μ be a common integrating factor for the system of equations (r) and let λ be its logarithm.

Then

$$\mu(P_r dx + Q_r dy) \equiv d\,.\,\{\phi_r(x, y)\}, \quad (r = 1, 2, 3).$$

Hence

$$\frac{\partial \phi_r}{\partial x} = \mu P_r\,; \quad \frac{\partial \phi_r}{\partial y} = \mu Q_r.$$

Using the relation

$$\frac{\partial^2 \phi_r}{\partial x \partial y} = \frac{\partial^2 \phi_r}{\partial y \partial x},$$

we obtain

$$D_r = \frac{\partial P_r}{\partial y} - \frac{\partial Q_r}{\partial x} = Q_r \frac{\partial \lambda}{\partial x} - P_r \frac{\partial \lambda}{\partial y}, \quad (r = 1, 2, 3). \quad . \quad . \quad (1)$$

Taking these equations in pairs and solving for the derivatives of λ, we obtain

$$\frac{\partial \lambda}{\partial x} = \frac{B_{rs}}{A_{rs}}\,; \quad \frac{\partial \lambda}{\partial y} = \frac{C_{rs}}{A_{rs}}\,; \quad (r, s = 1, 2, 3). \quad . \quad . \quad (2)$$

Thus, corresponding to Dalton's single condition,* which in our notation would be written $A_{12} \neq 0$, we have the three conditions (which are independent),†

$$A_{rs} \neq 0, \quad (r, s = 1, 2, 3), \quad . \quad . \quad . \quad . \quad (3)$$

but there is a further condition that equations (1) may be true simultaneously, viz.

$$\Delta \equiv 0. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This, of course, could not arise in the earlier work, which involved only two equations.

The commutative property then gives as the criterion for the existence of μ (or λ),

$$\frac{\partial}{\partial y}\left(\frac{B_{rs}}{A_{rs}}\right) = \frac{\partial}{\partial x}\left(\frac{C_{rs}}{A_{rs}}\right), \quad (r, s = 1, 2, 3). \quad . \quad . \quad (5)$$

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* See first note on previous page: (1), p. 189, or (2), p. 263. Dalton's notation is $\Delta \neq 0$.

† $A_{12} = 0 = A_{23}$ gives $\frac{P_1}{Q_1} = \frac{P_2}{Q_2} = \frac{P_3}{Q_3}$, from which $A_{31} = 0$, but this dependence of one condition on the other two does not follow when the $=$ sign is replaced by $\neq$.

If conditions (3), (4), and (5) are satisfied by the coefficients of the system (r), μ can be found, and will be not only an integrating factor common to that system, but will also be an integrating factor of the equation

$$\left(\sum l_r \mathrm{P}_r\right)dx + \left(\sum l_r \mathrm{Q}_r\right)dy = 0, \quad (r = 1, 2, 3), \quad . \quad . \quad (6)$$

where the l's are constants.

3. When the system (r) consists of m equations $(m > 3)$, the method of paragraph 2 may be applied again, and leads, as before, to the equations (1) and (2), where r, s may now be any two of the integers 1, 2, 3, . . . m. The conditions (3) must also be satisfied for these values of r and s. In paragraph 2 (where $m = 3$) conditions (3) may be reduced to the simple form

$$\frac{\mathrm{P}_1}{\mathrm{Q}_1} \neq \frac{\mathrm{P}_2}{\mathrm{Q}_2} \neq \frac{\mathrm{P}_3}{\mathrm{Q}_3},$$

and in the present case they take the form

$$\frac{\mathrm{P}_1}{\mathrm{Q}_1} \neq \frac{\mathrm{P}_2}{\mathrm{Q}_2} \neq \frac{\mathrm{P}_3}{\mathrm{Q}_3} \neq \ . \ . \ . \neq \frac{\mathrm{P}_m}{\mathrm{Q}_m}, \quad . \quad . \quad . \quad (7)$$

which simply means that the original m equations must be independent.

The condition (4) that the equations (1) may be satisfied simultaneously must be replaced by

$$\left\| \begin{matrix} \mathrm{P}_1 & \mathrm{P}_2 & \mathrm{P}_3 \ . \ . \ . \ \mathrm{P}_m \\ \mathrm{Q}_1 & \mathrm{Q}_2 & \mathrm{Q}_3 \ . \ . \ . \ \mathrm{Q}_m \\ \mathrm{D}_1 & \mathrm{D}_2 & \mathrm{D}_3 \ . \ . \ . \ \mathrm{D}_m \end{matrix} \right\| = 0, \quad . \quad . \quad . \quad (8)$$

where the notation means that the determinant obtained by taking any three columns of the matrix must vanish identically.

The conditions (5) must also be satisfied for $r, s = 1, 2, 3 \ . \ . \ . \ m$, and then μ is determined as a common integrating factor of the system (r) and of equation (6).

4. For the more general case of the system of equations (s), let

$$\mathrm{D}^r_{pq} \text{ mean } \frac{\partial \mathrm{P}_{rp}}{\partial x_q} - \frac{\partial \mathrm{P}_{rq}}{\partial x_p};$$

$$\mathrm{A}^{rs}_{pq} = \begin{vmatrix} \mathrm{P}_{rp} & \mathrm{P}_{rq} \\ \mathrm{P}_{sp} & \mathrm{P}_{sq} \end{vmatrix};$$

$$\mathrm{B}^{rs}_{pq} = \begin{vmatrix} \mathrm{P}_{rp} & \mathrm{D}^r_{pq} \\ \mathrm{P}_{sp} & \mathrm{D}^s_{pq} \end{vmatrix};$$

where

$$p, q = 1, 2, 3, \ . \ . \ . \ n \ ; \quad p \neq q \ ;$$
$$r, s = 1, 2, 3, \ . \ . \ . \ m \ ; \quad r \neq s.$$

Then the equations (2) for the derivatives of λ are replaced by

$$\frac{\partial\lambda}{\partial x_p}=\frac{B^{rs}_{pq}}{A^{rs}_{pq}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

The conditions corresponding to (3) and (7) take the forms

$$\left.\begin{array}{l} A^{rs}_{pq}\neq 0\,; \\ \dfrac{P_{rp}}{P_{sp}}\neq\dfrac{P_{rq}}{P_{sq}}\,; \end{array}\right\} \begin{array}{l} \quad . \quad . \quad . \quad . \quad . \quad . \quad (10) \\ \left.\begin{array}{l} p,\ q=1,\ 2,\ 3,\ \ldots\ n \\ r,\ s=1,\ 2,\ 3,\ \ldots\ m \end{array}\right\}. \quad . \quad . \quad (11) \end{array}$$

Conditions (8) are replaced by the aggregate of conditions,

$$\sum_{p,\,q=1}^{n}\begin{Vmatrix} P_{1p} & P_{2p} & P_{3p}\ \ldots\ P_{mp} \\ P_{1q} & P_{2q} & P_{3q}\ \ldots\ P_{mq} \\ D^1_{pq} & D^2_{pq} & D^3_{pq}\ \ldots\ D^m_{pq} \end{Vmatrix}=0, \quad . \quad . \quad (12)$$

while condition (5) becomes

$$\frac{\partial}{\partial x_q}\left(\frac{B^{rs}_{pq}}{A^{rs}_{pq}}\right)=\frac{\partial}{\partial x_p}\left(\frac{B^{rs}_{qp}}{A^{rs}_{qp}}\right), \quad . \quad . \quad . \quad . \quad (13)$$

p, q ; r, s having the same values as in (11).

If all these conditions are satisfied, μ is determined as a common integrating factor of the system (s) and also of the equation

$$\sum_{s=1}^{m}\sum_{p=1}^{n} l_s P_{sp}\,dx_p=0. \quad . \quad . \quad . \quad . \quad (14)$$

5. In order that the system considered in the preceding paragraph should remain quite general, it has been tacitly assumed that $m>3$, as well as $n\geqslant 3$. If, however, $m=1$, 2, or 3, certain alterations must be made in the forms of these results.

Case I. $m=3$.

The results of paragraph 4 may be written down with m replaced everywhere by 3, except that, in condition (12), the aggregate of matrices must be replaced by the aggregate of determinants,

$$\sum_{p,\,q=1}^{n}\begin{vmatrix} P_{1p} & P_{2p} & P_{3p} \\ P_{1q} & P_{2q} & P_{3q} \\ D^1_{pq} & D^2_{pq} & D^3_{pq} \end{vmatrix}=0. \quad . \quad . \quad . \quad (16)$$

Case II. $m=2$.

Again, all the results of paragraph 4 hold good, with m replaced by (2), except that we cannot get either the matrices of (12) or the determinants of (16).

Case III. $m=1$.

The single equation may be written as

$$P_1dx_1+P_2dx_2+\ .\ .\ .\ +P_ndx_n=0. \quad . \quad . \quad . \quad (17)$$

The search for an integrating factor leads to equations of the type

$$D_{pq}=\frac{\partial P_p}{\partial x_q}-\frac{\partial P_q}{\partial x_p}=P_q\frac{\partial\lambda}{\partial x_p}-P_p\frac{\partial\lambda}{\partial x_q},$$

$$D_{qr}=\frac{\partial P_q}{\partial x_r}-\frac{\partial P_r}{\partial x_q}=P_r\frac{\partial\lambda}{\partial x_q}-P_q\frac{\partial\lambda}{\partial x_r},$$

$$D_{rp}=\frac{\partial P_r}{\partial x_p}-\frac{\partial P_p}{\partial x_r}=P_p\frac{\partial\lambda}{\partial x_r}-P_r\frac{\partial\lambda}{\partial x_p}.$$

Multiplying these by P_r, P_p, P_q respectively, and adding, we get

$$E_{pqr}=P_pD_{qr}+P_qD_{rp}+P_rD_{pq}\equiv 0. \quad . \quad . \quad . \quad (18)$$

This is a condition that (17) may be integrated. There are $\frac{1}{3}n(n-1)(n-2)$ conditions of the type (18), of which $\frac{1}{2}(n-1)(n-2)$ are independent, for any one of the relations $E_{pqr}=E_{pqs}=E_{prs}=E_{qrs}=0$ may be derived from the other three,

$$(p\neq q\neq r\neq s).$$

When the conditions (18) are satisfied, the n derivatives of λ are not uniquely determined, and so no integrating factor is directly given by this method,* though any value of λ which satisfies the above conditions may be used as an integrating factor.†

If, when $m=1$, $n=3$, (17) takes the even more familiar form $Pdx+Qdy+Rdz=0$, and (18) gives only one condition, $E_{123}=0$, which is the well-known condition of integrability of the last equation.

6. In the preceding work we have not proved that systems actually do exist which satisfy all the conditions stated. That this is so may be seen by giving an example such as the following, which is a simple case of the system discussed in paragraph 2.

$$2\cos x\,dx-\sin x\tan y\,dy=0\,; \quad . \quad . \quad . \quad (19)$$

$$\sec^2 x\sec y\tan y\,dx+\sec x\operatorname{cosec} x\sec^3 y\,dy=0, \quad . \quad (20)$$

$$\sec^2 x\operatorname{cosec} x\tan y\,dx+\sec x\,dy=0. \quad . \quad . \quad . \quad (21)$$

* It is known, of course, that when $P_1, P_2, \ldots P_n$ are homogeneous in the variables $x_1, x_2 \ldots x_n$, an integrating factor of (17) is $(P_1x_1+P_2x_2+\ .\ .\ .\ +P_nx_n)^{-1}$, provided that $P_1x_1+P_2x_2+\ .\ .\ .\ +P_nx_n\not\equiv 0$, but no simple result of this kind holds good in the general case.

† *Cf.* Theory of Differential Equations, A. R. Forsyth, pt. i (1890), §§ 13, 14, 18.

We find

$$\frac{1}{\mu}\frac{\partial\mu}{\partial x}=\frac{\partial\lambda}{\partial x}=\frac{B_{12}}{A_{12}}=\frac{B_{23}}{A_{23}}=\frac{B_{31}}{A_{31}}=\cot x,$$

and

$$\frac{1}{\mu}\frac{\partial\mu}{\partial y}=\frac{\partial\lambda}{\partial y}=\frac{C_{12}}{A_{12}}=\frac{C_{23}}{A_{23}}=\frac{C_{31}}{A_{31}}=-\tan y.$$

Hence

$$\frac{1}{\mu}\frac{\partial\mu}{\partial x}dx+\frac{1}{\mu}\frac{\partial\mu}{\partial y}dy=\cot x\,dx-\tan y\,dy,$$

giving

$$\log\mu=\log\sin x+\log\cos y,$$
$$\mu=\sin x\cos y,$$

taking the simplest case when the constant of integration is unity.

This is a common integrating factor of equations (19), (20), (21). μ is also an integrating factor of the equation obtained by multiplying (19), (20), (21) by a, b, c respectively and adding the results, where a, b, c are any constants, the integral being

$$a\sin^2 x\cos y+b\sec x\tan y+c\tan x\sin y=k.$$

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SOME DEVELOPMENTS IN TECHNIQUE DURING THE EARLIER STONE AGE.

By A. J. H. Goodwin, M.A., F.R.A.I., F.R.S.S.A.

(With Plates VII and VIII, and one Text-figure.)

The history of the development of the Lower Palaeolithic cultures of Europe seems to have been marked by a series of sudden advances. A technique appears, continues relatively unchanged for a long period of time, and is eventually replaced by an entirely new and apparently independent technique, which is as fully developed as the old.

The industries of the Lower Palaeolithic period show a long and slow development from the Pre-Chellean to the end of the Acheulean, which achieves very little real advance. It would seem to have been confined in its evolution by the relatively slight adaptation of the flint nodule necessary to the making of an efficient *coup-de-poing*. Following directly upon this series and partly overlapping it appears the Levallois technique, fully developed, decidedly complex, and showing only slight similarities with the previous industries. The technique has been sufficiently well described by Commont * and others in various papers on the Somme River gravels, and also in most books on European prehistory, to need little further description here. In short, it comprises the preparation of a core (generally about 12 to 15 cm. in diameter) over both faces; the making of a carefully prepared, faceted striking-platform; and finally the removal from one face of the prepared core of a single usable flake, the form of which is governed by the trimming of the original nucleus. This technique is far in advance of that employed in the making of the true Chellean and Acheulean *coups-de-poing*, and the two methods show little real similarity. So great is this difference that we are forced to the conclusion that the technical developments which necessarily existed between the Acheulean and the Levallois type could not have taken place in Europe. In other words, Europe presents the first steps and the last in a development, but completely misses the intermediate stages.

It is the intention of this paper to suggest the intermediate stages between the technique of the Chellean and the Levallois phases, and as far

* L'Industrie Mousterienne, etc. (Le Mans, 1910).

as possible to explain their development. It is also intended to suggest that these extra-European stages occurred over widespread areas, and that they constitute the normal development, and that Europe is an isolated area which shows first a stagnation, and finally a triumphant grasping of the fully developed new technique in the Levallois. Two factors would seem to have caused this stagnation: the presence of glaciations along the Pyrenees and in the Alpine region, cutting Europe off from the remainder of the world; and the persistent use of the flint nodule, which never allowed (or forced) sufficient variation on the *coup-de-poing* theme.

It will be noticed that the prehistoric cultures of Europe are mainly situated in flint-yielding areas, and that even immediately outside those areas flint was traded and exchanged. The development of any new techniques and methods in the making of artefacts was almost everywhere directly dependent upon flint. Flint is a tough glass-like stone, often perfect in its cleavage under percussion or pressure, and extremely dependable. These qualities are most evident in the Grand Pressigny flint, but are also more or less present in all European flint in a good state. Its dependability has made flint the normal material for implement manufacture wherever it is found, and has obviously militated against any change of material. Now flint, while it occurs in blocks which are large, relative to the size of the implements produced, is awkward in shape, and the nodules or *rognons* generally need to be heavily reduced to remove the crust and the various processes and convolutions typical of the nodule form. As a result the eventual blocked-out stone from which the tool is to be made must be small, and a conveniently large tool, such as was typical of the Chellean and Acheulean of Europe, must necessarily have been shaped by a method giving the minimum of wastage. The technique employed in Europe fulfils this very necessary condition. But directly a flint area is left, larger material is at man's disposal, and is in fact actually forced upon him, and developments in technique become possible as soon as the strong need for economy is eliminated.

Abbeville Technique.

It would seem necessary in introduction to outline the technique of the true Chellean and Acheulean cultures—that is, the cultures typical of the flint-bearing areas of Western Europe, as best exemplified in the Somme River gravels and described by Boucher de Perthes, Commont, Breuil, and others. This technique I have called for the purposes of this paper the Abbeville technique.

The method used in the making of the *coup-de-poing* in Europe was

simple ; so simple was it, and so persistent both here and elsewhere, that we may regard it as the morphologically " primitive " technique of the series. A suitable flint nodule was taken and roughly trimmed to a block perhaps 12 cm. in diameter and 5 cm. thick. Blows were now struck on the one face in such a manner as to remove flakes from the opposite face, and to give the artefact a roughly almond-shaped outline. The implement was turned over and these flake-scars used as a striking-platform for the removal of a series of flakes from the face previously struck. This striking of alternate faces was repeated until the desired symmetry and form were achieved. During the Chellean phase the process was stopped relatively soon, and a crudely flaked *coup-de-poing* with sinuous, jagged edges resulted. As the Lower Palaeolithic went on the technique was carried further, and finer, more delicate blows were struck to give a more perfectly modelled tool. With the Acheulean phase (according to Breuil) would seem to have appeared a new technical method—the use of a billet of wood in place of a stone hammer for removing the unwanted spalls in the process. This new tool seems to have produced a flatter cleavage, a result due in all probability to the greater " follow through " of a blow struck with wood on stone. However this may be, there is a considerable fining of the original technique, but no further advance in methods until the close of the Acheulean.

Tachengit Technique.

While this stagnation was true of flint-using Europe it did not apparently occur elsewhere. In 1925, M. M. Reygasse of Algiers, writing for the Archaeological and Geographical Society of Constantine,* described a number of implements discovered in the Western Sahara by Captain César, which eventually reached the Institut de Paléontologie Humaine de Paris ; and also a second series from Colomb-Bechar and Beni-Abbes, now in the Musée du Bardo, Algiers. The types he describes consist of large flakes, struck from a core, and shaped to a rough axe form by trimming on the one face only. The other face is made up of the plane of cleavage from the core, but often with the bulb of percussion carefully trimmed away.

" The special material collected at Tachengit by Captain César is made up of a double series of tools (generally of a red silicious limestone), which would appear to me to have been contemporary in spite of the morphological differences observed. The material comprises axes of Acheulean type, and also a considerable number of points (*pointes à main*), very bulky, being at least 14 cm. long and 11 cm. at the base. These points are obviously of the same size as the *coups-de-poing* of Acheulean technique

* Reygasse, Haches retouchées . . . de Tachengit, etc. (Constantine, 1925).

from the same site; the same applies to the *coups-de-poing* which have been retouched over one face only, and which show, at the end opposite the striking-platform, a neat edge. This edge is generally straight, but it may also be convex or even concave in form. On these pieces are to be seen lateral nicks (*encoches*) intended to make the holding of the implement easy. These nicks are both either neatly retouched, or else merely the result of the removal of a large flake at the base of the bulb of percussion. The length of the implements is in the neighbourhood of 17 cm., their width at the base 10 cm., and they weigh at least 75 grammes" (see text-fig.).

The forms described, the whole collection of which I have seen in Paris and Algiers, are directly comparable, and indeed identical, with much of the South African Stellenbosch material in Table Mountain Sandstone as seen along the Southern Mountain Region * of the Cape, and also in other regions. The extreme likeness existing between the types from Tachengit and from the Cape is largely due to the similarity of material, the red-brown silicious limestone being almost identical with Table Mountain Sandstone in its behaviour, occurrence, and cleavage.

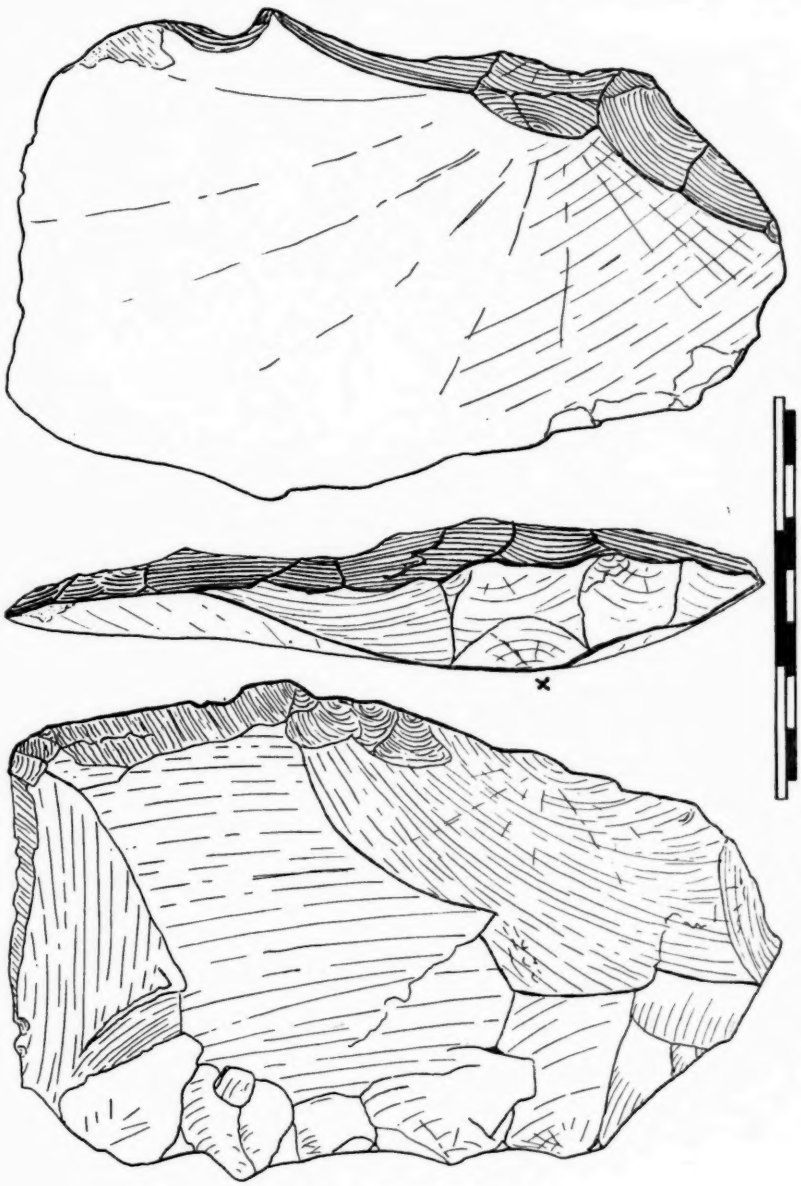
The distribution of this variation can be traced all over Southern Africa to the Zambesi, and is only lost there because of the paucity of the material available. From Kenya Leakey † illustrates several specimens, the most obvious being of quartz-trachyte, on pl. viii. In South Africa the term *biseau* has been used, in Kenya Leakey uses the preferable term cleaver, to describe the artefact. It would seem from this and other evidence that the type is common all through Africa. Its further distribution is worthy of note: Perez de Barradas and Obermaier show its presence in Spain, and I myself have found an excellent specimen in the Garonne River gravels. Here again the material used is similar to that employed in South Africa. From India similar types have been described by Burkitt and Cammiade.

I have noted the presence of this type (the cleaver or *biseau*) at perhaps a hundred sites along the southern littoral of South Africa, and the origin of the side-flake upon which the cleaver has been made has always proved a difficult question. Recent discoveries in South Africa have thrown considerable light on the technique, which for the purposes of this paper I shall refer to as the Tachengit technique.

Recently I visited two sites on the farm Silverhurst, in the Constantia Valley, through the courtesy of Dr. and Mrs. R. G. Haines. The farm is situated near the main mass of Table Mountain, on two foothills whose geological history is difficult to disentangle, but it would seem that they originally formed one of a series of interlocking alluvial cones from this (the south-eastern) aspect of Table Mountain, which has since been divided

* Goodwin, Ann. S. Afr. Mus., vol. xxvii, 1929.

† Leakey, Stone Ages of Kenya (Cambridge, 1931).



TEXT-FIG.—Tachengit cleaver. (*Musée du Bardo, Algiers.*)

by a tributary of the Diep River, as the barometric heights of the sites above stream-level are almost identical, both being in the neighbourhood of 70 feet. There is nothing to suggest the presence of a river gravel, though all the specimens have been slightly rolled by water-action.

The specimens from both terraces are similar, save that the south terrace has yielded three specimens of cylindrical cores, 8 cm. in diameter, and of a similar depth, from which parallel flakes with an unprepared striking-platform have been struck, perhaps 3 cm. wide, and the length of the core. These, like the remainder of the material, are of the local Table Mountain Sandstone. A few relatable flakes were found, but they bore no signs of secondary retouch. These cores and flakes recall a simplified "Neanthropic" technique. Besides these elements, which show no reason for divorce from the remainder, the south terrace shows *biseaux* (cleavers), rough *coups-de-poing*, debatable scrapers of a crude type, and an equally debatable heavy core-scraper, all quite certainly related, and all made from heavy flakes.

The north terrace is capped by a reddish alluvial soil which has been quarried to a depth of 3 feet, and a number of artefacts have been thrown up in the process. In the main these resemble the larger material from the south terrace, but although a careful search was made, no small flakes or their flake-cores were found on this portion of the site.

The most important find from this locality was a single large fragment of rock which had been prepared and used as a core from which had been successfully removed two or three large side-flakes, about 20 cm. wide by 12 cm. deep, identical with the flakes from which the cleavers were made. The core is generally irregular in section, and resembles the formless fragments of rock generally accepted as picks used in quarrying from standing rock, though it would seem to have been trimmed to resemble an enormous *coup-de-poing* before the removal of the large flakes marked with an arrow in Plate VII, *a*. The specimen measures 41 cm. long by 20 cm. at its greatest diameter. The use of this core was recognised immediately, but, in spite of a smaller and more debatable specimen being found on the site, judgment was reserved.

It is worthy of note here that from their positions relative to the stream beds, and to the present land surface, there is reason to believe that the Stellenbosch material from Kirstenbosch, a site further round the mountain to the north-west, is older than that from Silverhurst. Further down the Liesbeeck River, below Kirstenbosch and in gravel quarries cut into alluvial soil, are implements identical with Silverhurst forms and showing like technique; side-flakes, *biseaux*, well-finished *coups-de-poing*, and a few debatable flake-tools. The relative positions of these implements to the stream suggests that we are here dealing with two distinct phases of the

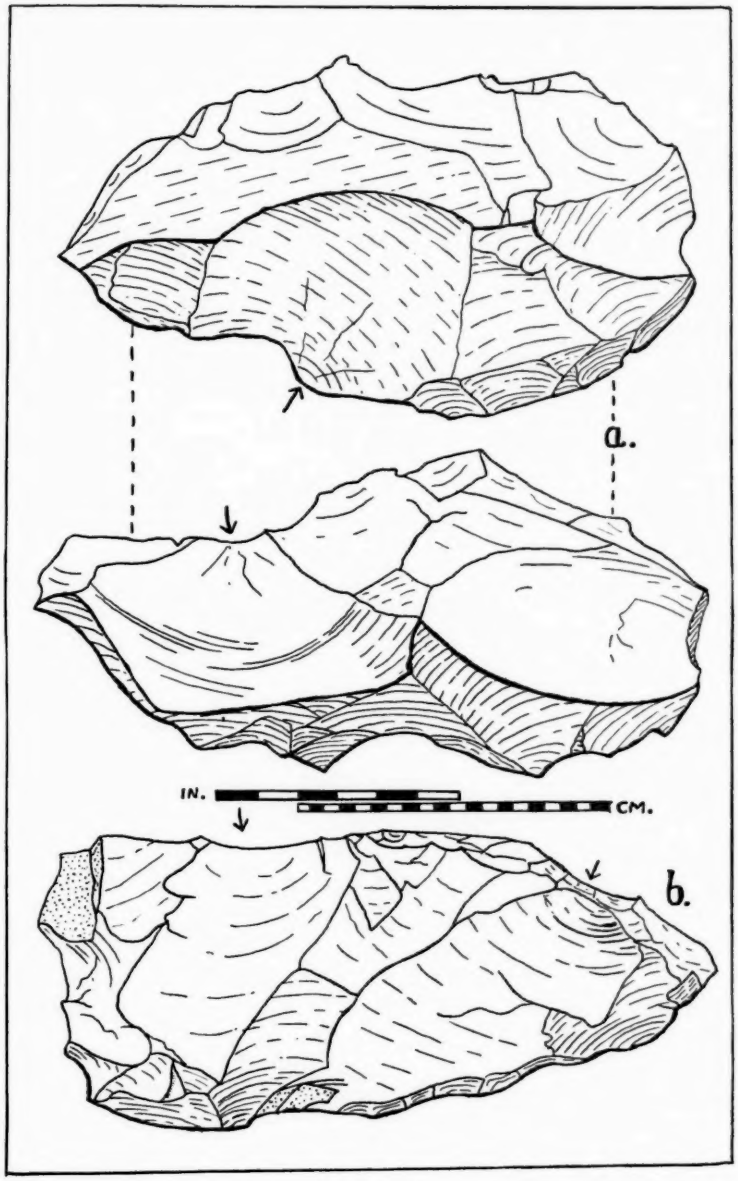


PLATE VII.

a, Core from Silverhurst, Constantia Valley.
b, Core from Fish Hoek Valley.
The position of the major flakes removed is indicated by arrows.

Stellenbosch culture, though no absolute proof is forthcoming. The Silverhurst material is similar to that below Kirstenbosch, but dissimilar from the forms found at Kirstenbosch itself. The earlier material shows no *biseau* forms of the type we are here discussing.

Subsequent to the visit to Silverhurst, I recognised a similar, but even more convincing core (with a crude striking-platform and not resembling the crude *coup-de-poing* form of the Silverhurst specimen) which had been brought to Mr. B. Peers as part of a load of stone. The load had been collected from a known Stellenbosch site in the neighbourhood, and the core is identical in weathering and patination with other implements from this site. It is certain, therefore, that we are dealing with a comparable specimen (Pl. VII, *b*).

There arises the question of identifying the South African *biseau* or cleaver types with those of Tachengit. Both are normally made of side-flakes, and the methods employed are demonstrably the same. In both cases the bulb of percussion is frequently removed by a series of secondary flakes, which gives a result simulating very closely the prepared striking-platform of the Victoria West and Levallois techniques. This last fact very strongly suggests that the characteristic butt which resulted was found to be sufficiently useful to merit incorporation (at an earlier stage in the process it is true) in the two later techniques, and to be very beautifully developed in the late Levallois.

One point of evidence of identity is still lacking, as no cores are yet known from Tachengit sites, but this may be due to the same causes which prevented such cores from being discovered in Southern Africa, or if discovered, reported. We may therefore presume that if these two variations are not identical, they are sufficiently akin to each other to merit their inclusion as a single stage in the development.

The Victoria West Technique.

For some considerable time since their first discovery by the late Mr. Jansen, peculiar types of artefacts have been found in and about the Karroo town of Victoria West. These objects have one feature in common, despite their slight differences in shape and size : each has on the one face a scar, marking the removal of a single large flake which must originally have taken up two-thirds of the original core face. From its regular association with *coups-de-poing* this industry was relegated to the Earlier Stone Age—a period perhaps comparable with the Lower Palaeolithic of Europe—and the industry was regarded as a local variation. The difficulty in realising the use of these objects lay in the extreme weathering of the dolerite, of which most of the artefacts were made.

This was the state of our knowledge when a paper was written on the Victoria West industry * as part of a general work on the Stone Age cultures of South Africa. In that paper the regular occurrence of the *coup-de-poing* with the peculiar artefacts under discussion was insufficiently stressed, and overmuch emphasis was laid on these latter.

In July 1929 the anthropological section of the British Association visited the diamond-bearing gravels of the Vaal River, at Canteen Kop, and at Pniel. The Canteen Kop gravels are situated perhaps a mile south-west of Barkly West. At this point there are three gravels, the highest apparently pre-human, capping the hill, the second at a height of some 60 feet above the present river-level, which is the gravel under discussion. The third lies a little above river-level, but on the southern side of the Vaal. The Canteen Kop gravels form the second of this series. On a previous visit to these gravels the writer had only found a few *coups-de-poing*, heavily rolled and of a coarse type.† The diggings had apparently reached rich implement-bearing layers since that time, for when the Association separated, the Abbé Breuil, Mrs. Harper Kelley, and the writer discovered an abundance of Victoria West forms in different parts of the diggings. These constituted the first finds of this industry from this portion of the river, though Mr. Burkitt had discovered a single unassociated specimen some few miles away on the surface, behind the old Half-way House between Kimberley and Barkly West.‡

The Abbé pointed out that on the evidence of the state of rolling of the included implements there would appear to be three lithicultural horizons. (1) The oldest is represented by cleavers and *coups-de-poing* of a coarse, heavy type, usually large, flat, and unwieldy. These implements are very heavily rolled, and would seem to have been included in these gravels from a higher level. (2) The second series shows better-made implements, made consistently on a laterally struck flake. This material is lightly rolled, but the flake-scars are fresh, the interjacent ridges being slightly rounded. This group is also differentiated by bearing considerable marks of iron-staining, from which the other horizons are free. The artefacts seem to have been made from gravel material actually *in situ* and during deposition. (3) The final phase shows similar material, slightly smaller, well made, and also made on side-flakes. These last two periods are also represented at the better-known site at Pniel. The material used throughout is an amygdaloidal diabase.

As a result of a later visit to the Canteen Kopje site in August 1929

* Goodwin, "The Victoria West Industry," Ann. S. Afr. Mus., vol. xxvii, 1929.

† Goodwin, "The Archaeology of the Vaal River Gravels," Trans. Roy. Soc. S. Afr., vol. xvi, No. 1.

‡ Burkitt, South Africa's Past in Stone and Paint (Cambridge, 1928).

with Mr. J. G. van Alphen, the writer found a considerable number of additional " tortoise-cores " of the Victoria West type, similar to those previously discovered here, but in sufficient numbers to allow of further conclusions being arrived at.* These showed three distinct types, the earliest heavily rolled, and belonging to horizon (1), and identifiable with the *coup-de-poing* and cleaver material of his period. All these specimens belong to Jansen's *hoenderbek* (cock's head) type (Plate VIII, 4).

The second series has been almost untouched by rolling, the implements are heavily stained with iron, and the technique resembles that employed in Breuil's horizon (2, above). All the specimens belong to Jansen's " high-backed " type. The workmanship is extremely crude, and is often even cruder than in series (1) (Plate VIII, 3).

The third series shows an extreme advance. The form is still much the same as Jansen's " horse-hoof " type, but flatter and far better made. The flaking becomes long and narrow and the technique much more sure. These specimens are in a completely unrolled state (Plate VIII, 1).

We would thus seem to have a double sequence of types running parallel: Stellenbosch material in three horizons and Victoria West material in three horizons, and the material in each horizon corresponds, each to each. This gives us a definite sequence, showing a considerable refinement of the workmanship on the cores, most noticeably in the third phase, and at the same time two distinct changes in the form of the nucleus used.

Description of the Artefacts.

The cores of Victoria West type show a general similarity, and consist of large stones, 15 to 20 cm. in diameter by 10 cm. in thickness, shaped to the form of a heavy *coup-de-poing*. They are bounded by a zigzag edge, formed by the removal of a series of flakes from about the perimeter.

The method employed in their making seems to have been the following. A block of stone, generally a large flake struck from a river boulder, was heavily trimmed by striking flakes consistently from one face. The object thus formed would have one flat face (the striking-platform of these first trimming flakes), and be bounded by an edge with an angle of about 60° to the striking-platform. The block was turned over and the same process repeated, using the first series of flake-scars as a striking-platform. The resulting form consisted of a rough block, similar in shape to the *coup-de-poing*, but far larger. One face of the block was considerably more convex than the other, even pyramidal. This more convex face I shall refer to as the " under face," and the other as the " upper face."

* This collection is housed partly at the McGregor Museum, Kimberley, and partly at the University of Cape Town, Rondebosch.

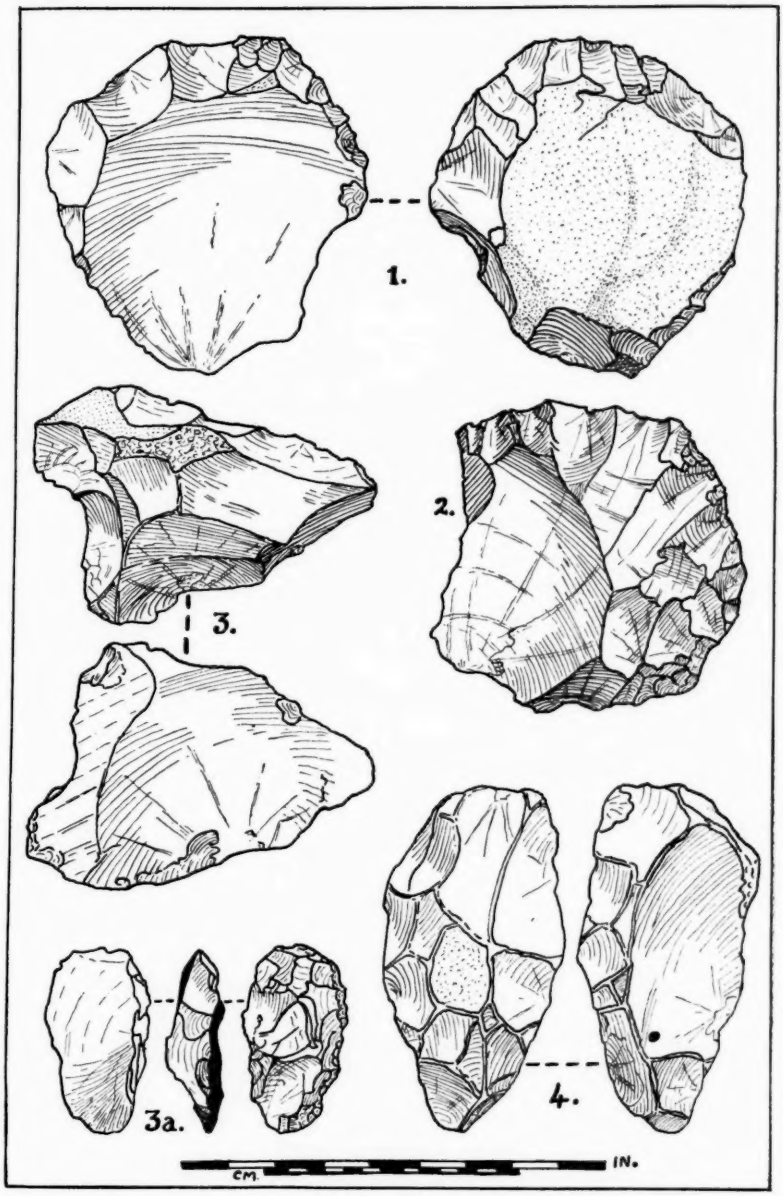


PLATE VIII.

1 and 2. Cores of third period. 3 and 3*a*. Core and *coup-de-poing* of second period.
4. Core of first period. All from Canteen Kop. (*University of Cape Town Collection.*)

At this point in the process a few small, almost negligible flakes were struck from one edge by blows on the upper face. This made a convenient platform, and a final heavy blow was struck here which completely removed a large flake covering about two-thirds of the upper face, leaving a deep flake-scar in its place. The upper face of the core now showed fragments of the original trimming flakes, cut into and truncated by the major flake-scar. The major flake bore the remainder of the same trimming flakes, and this now became the object of the maker's interest.

This study of the core was based upon the analysis of some forty specimens, and care was taken to note the consistent order of the four steps in each case :

(*a*) Preparation of convex under face.
(*b*) Preparation of upper face.
(*c*) Preparation of striking-platform.
(*d*) Removal of final flake.

In many instances step (*c*) had been omitted or only cursorily attempted ; indeed it may not be present at all in the earliest (***hoenderbek***) forms, but the rolled state of this material makes this point impossible to elucidate. In two instances I have obtained types from this earliest series from which no final flake has been struck, and one specimen from the last phase in which the final flake has been unsuccessfully struck, so that less than a quarter of the upper face has been removed (Plate VIII, 2). A study of these various specimens confirms the technical order suggested above.

The flake must therefore have consisted of a rough disk, one face of which was made up of a positive flake-scar, the other of a number of negative flake-scars, both whole and partial. In order to obtain untrimmed specimens (none could be found on the site) flakes were carefully reconstructed on struck cores. The curves of the trimming flakes were followed out and a theoretically correct reconstruction of an unstruck core obtained. On comparing the thickness of the reconstituted flake with that of the small *coups-de-poing* and cleavers made from similar flakes, it was found that both measured about 3 cm. at the maximum. This finally removed any possible doubts as to the identity of the finished implements with the final flakes struck from such cores.

The flake implements consist of *coups-de-poing* and cleavers, all of which show part of a positive cleavage scar on one face. In some instances little has been done to the major flake save that it has been trimmed across, parallel to the striking-platform, flakes being struck from the positive cleavage face to truncate the major flake. The resulting form is a double-ended cleaver. In other instances this final trimming has been brought round to meet the striking-platform at one end to form a single-

ended cleaver. Both these types I still consider to be rejects thrown out in the making of the *coup-de-poing*. The artefact becomes a fully finished *coup-de-poing* when the truncating trimming is continued round to meet the striking-platform at both ends, and a slight amount of additional trimming has been done (Plate VIII, 3*a*).

There is no great difference in form between the small implements of the first phase and those of the second and third save a general diminution in size.

The *coup-de-poing* now shows one face bearing the flake-scars from the original trimming of the core, and the other composed of the positive cleavage scar. The two lateral edges consist of the curved striking-platform on the one edge and the final trimming flakes on the other. It is interesting to note that in all cases observed the final trimming flakes alone of all those used in the process are stepped or resolved. This final trimming necessary to the production of a serviceable, though small (for Africa) implement is so slight that the work entailed in preparing the core is vindicated.

The technique employed at Victoria West is thus comparable with the Levallois technique of the Somme Valley, of Northfleet, and similar sites, and with Abbott's "prestwich and evans" types.* Breuil, in a short review of his African material,† has recently suggested that this Victoria West technique is a morphological precursor of the Levallois. Lowe, writing in Bantu Studies on the results of Breuil's visit, gives some interesting remarks on this site. Here "we have revealed to us a technique not unlike a magnified and slightly distorted Levallois of Europe. We have a large flake, destined to become an implement, struck from a prepared core,—a technique revealing adroit craftsmanship, more especially to be admired when we realise we are dealing with an industry that belongs integrally to a Lower Palaeolithic period." ‡ The differences between the two techniques are slight; in the Levallois the striking-platform is more carefully prepared to form a very decided "Cupid's-bow" curve at the butt-end of the flake.§ The Levallois flake, through all the six periods defined by Breuil, is an end-flake, in contrast with the Victoria West, which is generally a side-flake until the final period demonstrable at Barkly West, when it becomes almost an end-flake (Plate VIII, 1). The Levallois flake seldom shows any trimming, and both the flake and core are smaller than the Victoria West types.

* Abbott, W. J. Lewis, "Classification of the British Stone Age Industries," Journ. Roy. Anth. Inst., vol. xli, 1911, pp. 458–481, pls.

† Frobenius and Breuil, Afrique Cahiers d'Art (Paris, 1931).

‡ Lowe, C. van Riet, Fresh Light on Prehistoric Archaeology: Bantu Studies, iii, 4, 1929, p. 389.

§ Commont, *op. cit.*, and various other publications on the Somme River gravels.

The distribution of the Victoria West core is of interest; in South Africa it would seem to be fairly confined. It is known all along the Vaal River, and at Victoria West, Nakop on the South-West African border, and at one or two sites within this general region.* Evidence further suggests that cores of this type may be expected in the Southern Mountain Region and elsewhere, but only one or two very doubtful examples have so far appeared. In North Africa a single unassociated core is in the collection of M. A. Debruge at Constantine, the only remaining artefact in his collection, the remainder of which has passed to America. It was found by him at a considerable depth in an erosion gully beside the Tebessa road. The core bears the impression of a strongly "plunging" flake, and is therefore anomalous. Suggestive material has been found by Wayland in Uganda, and relegated by him to his Sangoan industry. From India M. Cammiade, with Burkitt, has recently described in "Antiquity" types identical with the South African specimens.

From the evidence it would appear, therefore, that we are dealing with a very wide manifestation of a single technique, complex and decided, and not with a local and eccentric variation.

Conclusions.

We have now sufficient data at our disposal to suggest a morphological sequence of at least five stages in the development of a single cultural progression.

1. A stage, best represented by the Somme Chellean, in which flint nodules, or simple river pebbles, were trimmed to shape (Abbeville technique).

2. Probably a variant of this, but more widespread in areas where suitable small pebbles were absent, is the use of a large flake struck from an untrimmed river boulder.

3. The use of a large rock-fragment as a core from which several flakes were struck. A simple platform was prepared by the removal of large flakes, or the whole core formed to the shape of a rough *coup-de-poing*. The bulb of percussion was often removed from the resulting implement by a number of trimming blows, though in some cases the striking-platform is more carefully prepared (Tachengit technique).

4. The use of a carefully prepared core from which one final lateral flake only was struck, and trimmed to *coup-de-poing* form; striking-platform carefully prepared (Victoria West technique).

5. The use of a carefully prepared core from which one final end-flake

* See Burkitt, *op. cit.*, and Goodwin, Ann. S. Afr. Mus., *loc. cit.*

was struck, but generally left untrimmed. The striking-platform was prepared with the utmost care (Levallois technique).

To this series may be tentatively added, for consideration by European scientists, two further suggestions, which I have not supported in this paper:

6. The Mousterian technique would seem to have been a further development of this series.

7. The Grand Pressigny technique, in spite of its late appearance, shows a very decided affinity with the series.

It may be argued that these various developments were forced by the need for adapting technique to material. This is most certainly true, and throughout South Africa there is a continual reversion to Types 3 and 4, but in a decreasing proportion. When Type 4 was developed this tendency to revert became appreciably less. We may deduce from this that until Type 4 was evolved a usable nodule or pebble was still preferable where it could be found.*

We thus have a morphological sequence the elements of which did not necessarily form a time-series as we now know them, but probably spread and survived in various parts of the world over considerable periods.

If this developing progression is accepted, then the Acheulean must inevitably be described as a localised and circumscribed phase typical of a flint-yielding country, which failed to be influenced by these major developments occurring more generally elsewhere until the completed Levallois technique returned to those regions fully developed. The Tachengit and the Victoria West techniques represent the normal development, and hence deserve a major place, and should not be described by the extension of such terms as Chellean and Acheulean, even where the end-product (the *coup-de-poing*) shows a superficial similarity to those of either of these phases.

I desire to express my thanks for a Carnegie Grant, received through the Research Grant Board, for the purpose of research in the Western Mediterranean area.

* In most materials, especially in our dry, hot climate, river pebbles tend to break down and to lose their cohesion.

AN INTERESTING NEW MYCTOPHID FISH FROM SOUTH AFRICA.

By J. L. B. Smith.

(With Plate IX.)

Family Myctophidae.

Genus *Myctophum* Raf.

The subdivision of the numerous polymorphous species of this genus has proved attractive, if somewhat troublesome. Goode and Bean (Ocean. Ich., 1895, p. 71) proposed an elaborate scheme, which has little practical or taxonomic value, since it is based mainly upon features which can have but little natural significance in these fishes. A simple and more natural scheme, based upon the nature and arrangement of the luminous organs, in the form in which it has been suggested by Brauer (Zool. Anz., 1904, vol. xxviii; Wiss. Erg. Deutsch. Tief-See Exp. Valdivia, 1906, vol. xv, pt. 1) has been accepted by most systematists. Brauer considers that there is but a single genus, *Myctophum* Raf., but recognises the four subgenera *Myctophum* Raf. s.s., *Lampanyctus* Bon., *Diaphus* Eig & Eig, and *Lampadena* G. & B.

Since all species hitherto discovered have fallen more or less satisfactorily into one or other of the subgenera, these have acquired a possibly fictitious taxonomic significance, and Parr (Bull. Bing. Oc. Coll., 1928, vol. iii, Art. 3, p. 49) has proposed the raising of the subgenera to full generic rank. This may prove to be of doubtful value, since, not only is our knowledge of these fishes far from complete, but renewed subdivision of *Lampanyctus* and *Diaphus* is almost certain to be proposed.

The remarkable specimen described below does not fall within the limits of any one of these proposed four genera, but would appear to call in question the full generic distinction of *Lampanyctus* from *Diaphus*, since it to some extent bridges the gap between them, but also possesses certain features characteristic of neither. This would appear to involve either renewed subdivision of *Diaphus*, or the institution of yet another subgenus of the single wide genus *Myctophum*. The latter alternative appears preferable, and is here adopted.

Nasolychnus, new subgenus.

No luminous plates on peduncle. Luminous scales present or absent. Antorbital organs enlarged, probably always continuous above and below nostrils. Photophores circular, without dividing septum; five, or more or less than five, precaudal. The two infrapectoral organs probably never in line with the first pectoral organ. Spongy, probably luminous, tissue between the ventral bases, not corresponding with the scale pockets. Maxilla extending well behind eye, posteriorly dilated.

This subgenus is closely related to *Diaphus*, from which, however, it differs in several features.

Myctophum (*Nasolychnus*) *florentii* n. sp.

Body elongate, moderately compressed, width 1·7 in depth. Dorsal profile even, snout blunt, almost vertical before eye. Depth 5·1, length of head 3·9 in length of body. Eye 4 in head, 1·8 times snout, 1·2 in interorbital width, and 2·6 in the postorbital part of the head. Strong median ridge on snout. Preopercle margin very oblique. Mouth large, maxilla extends 1·7 times eye diameter behind eye, posteriorly dilated. Minute teeth in both jaws and on palatines, pterygoids, and tongue: a few rudimentary teeth on sides of vomer. Gill rakers 25, slender, 2 in eye.

D 19, commences above the ventrals, 5th ray longest, 1·7 in head, last ray 4 in head. Edge of fin straight. Base of dorsal as long as head. Adipose dorsal just behind end of anal base.

A 19, commences below the 14th dorsal ray, 5th ray longest, 2·1 in head, last ray 6 in head, edge of fin gently concave. Base of anal 1·25 in length of head.

P 12, inserted in lower third of side, 3·3 in head, does not reach to ventral base. V 9, inserted twice as far from base of caudal as from centre of eye, 1·7 in head, reaches to vent. Caudal deeply forked, densely scaled.

Photophores circular, without dividing septum. (Brauer's terminology is here employed.) PLO much nearer lateral line than pectoral base. Upper PVO above pectoral base, lower behind upper. The PLO and the two PVO form an almost straight series with the 2nd (? 3rd, *vide infra*) PO. 5 PO, first twice as far from second as remainder from one another (there may have been 6 PO, since on each side the scale behind the anterior PO is missing, see figure). VLO twice as far from ventral base as from lateral line. 5 VO in a gently curved series, 3rd highest. 4 SAO, the anterior three forming a gently curved oblique series with the posterior VO. Upper SAO in lateral line, forming a straight oblique series with posterior (4th) SAO and first antero-AO. 7+9 AO. 2 Pol, upper almost in lateral line, in a straight oblique series with last antero-AO. On one side 4+1 Prc,

separate from AO, last separate, highest, just below end of lateral line: on the other side there are 1 + 2 + 1 Prc, the posterior as before, the remainder being arranged 1 + 2, with two rudiments between. Branchiostegal organs 3, obscure. On one side 3 opercular organs, upper small; lower two large, contiguous or partly fused, expanded ventrally. Upper organ absent on other side. Antorbital organs conspicuously enlarged, continuous above and below nostrils. A cuneiform patch of white, probably luminous tissue between ventral bases, about half eye diameter in length, not covered by scales and not corresponding with the scaling. No luminous plates. No true luminous scales, but most scales on the body and the top of the head with a central irregularly shaped light patch, probably luminous. Dorsal sheath scales mostly with central luminous patch. Edges of fontanel white, probably luminous.

Scales cycloid, l.l. tubes 46, l.l. scales not enlarged, l.tr. $\frac{4}{8}$ (from origin of dorsal), about 15 predorsal, 4–5 scales on cheek.

Colour.—Uniform brown, antorbitals bright silvery. Photophores opalescent with black tissue before and behind. Proximal third of ventrals light.

Length.—136 mm.

Type.—A ripe female, in the Albany Museum.

Locality.—Bushman's River, near Port Alfred, found on the shore by Miss Florence Hewitt.

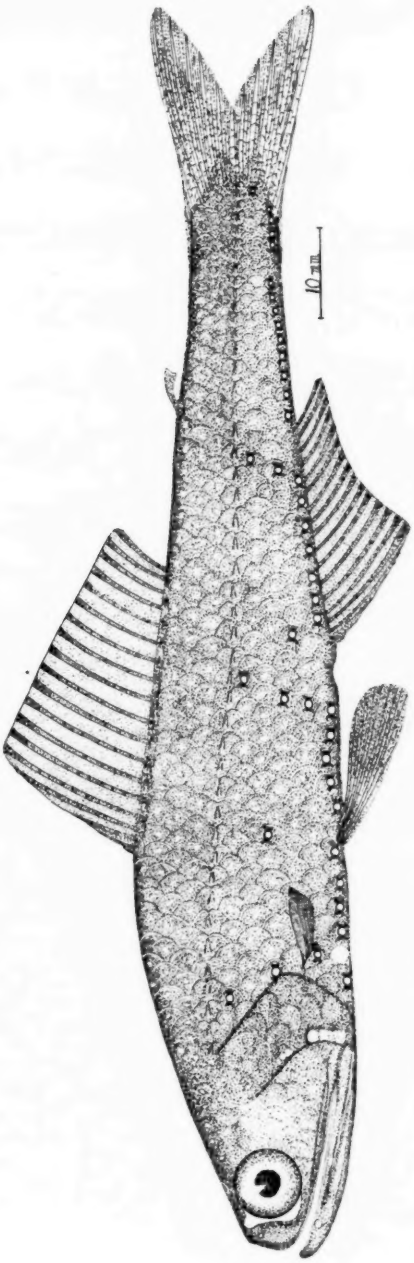
The photophores on the cheek, and the Prc, as indicated above, are not the same on both sides. The 4 + 1 Prc is evidently normal, while the 1 + 2 + 1 on the right side is most probably not, since there are two rudimentary or defective organs between the first and the second.

It is an open question whether the photophores here described as the posterior (4th) SAO, and as the lower Pol, might not be regarded as the first and the ninth antero-AO respectively, elevated above the rest. Since the remaining AO are in two regular horizontal series, it appears preferable to regard these others as belonging to the SAO and to the Pol respectively.

Considering that this remarkably large specimen was cast up by waves, although some of the scales are missing, it is in a remarkable state of preservation, so as to lead one to conclude that even a somewhat fragile dividing septum, such as is present in *Diaphus*, would still be intact in some of the photophores, had it originally been present.

The eggs are about 0·6 mm. in diameter, and are certainly exceedingly numerous.

Albany Museum,
Grahamstown.



Myctophum (Nasolychnus) florentii n. sp.

J. L. B. Smith. *Neill & Co., Ltd.*

THE SOUTH AFRICAN SPECIES OF THE GENUS *HEMIRHAMPHUS* CUV.

By J. L. B. Smith.

Genus *Hemirhamphus* Cuv.

(With Plates X–XII and one Text-figure.)

Cuvier, Reg. Anim., 1817, ii, p. 186.

Body elongate, subcylindrical or compressed. Lower jaw produced into a long beak, with teeth only in the part opposite the edges of the premaxillae. A cutaneous fringe from corner of mouth on each side to apex of beak: a median bilobed sac expanded at origin below the chin, tapering forward to below tip of beak. Premaxillae, fused with maxillae, produced, forming a flattened triangular upper jaw, naked or scaly. Teeth small, conical, bi- or tricuspid, in bands in both jaws. Ventrals abdominal, nearer to base of caudal than tip of upper jaw. Pectorals inserted above middle of side, not longer than head. Dorsal originates far back, much nearer base of caudal than base of pectoral. Caudal forked or emarginate, the lower lobe longer. Scales cycloid, moderate or large, deciduous. Lateral line ventro-lateral in position, commences on chest, ends before base of caudal: a superior branch to pectoral base. Lateral line tubes with few or many inferior tubules. Gill-openings wide, gill-rakers numerous, well developed. Third upper pharyngeals fused. Air-bladder simple or cellular.

Subgenera of *Hemirhamphus* Cuv. have several times been proposed. Gill (Proc. Ac. Nat. Sci. Phil., 1859, p. 131) instituted the genus *Hyporhamphus* for species with ventrals inserted nearer head than caudal base, and air-bladder simple. Fowler ("Fishes Oceania," Mem. B. P. Bishop Mus., 1928, x, p. 75) has proposed the subgenus *Rhynchorhamphus* for species with triangular part of upper jaw longer than wide, beak very long, and ventrals nearer caudal base than head. To *Hemirhamphus* (s.s.) are then assigned species with ventrals nearer caudal base than head, upper jaw wider than long, and air-bladder cellular.

The position of the ventrals appears to be a most unsatisfactory feature on which to found an allied genus, or even a subgenus of *Hemirhamphus*,

for in the species we find regular variation of this position from midway between caudal base and tip of pectoral to midway between caudal base and eye, several species having the ventrals inserted exactly midway between caudal base and head. The shape of the upper jaw and the length of the beak have little to recommend them as features for a similar purpose, since it is shown in the present work that these vary considerably with the growth of the fish.

The South African species alone show the doubtful utility of the subgenera as defined above: *delagoae* Brnrd. has the simple air-bladder of *Hyporhamphus*, but the ventrals inserted as in *Hemirhamphus*; *knysnaensis* n. sp. has the ventrals inserted midway between caudal base and head, thus falling midway between *Hypohamphus* and *Hemirhamphus*, the triangular part of the upper jaw in adults longer than wide, as in *Rhynchorhamphus*, but the beak is not very long, while the juvenile stages have the upper jaw wider than long, or as wide as long, according to the stage of growth.

I cannot therefore accept the present forms in which the above subgenera appear.

Generic subdivision may more sharply and with greater justification be based upon other features, such as the presence or absence of scales on the triangular part of the upper jaw, which is constant at all stages, or upon the nature of the growth changes observed during the early and mid-juvenile stages. As will be seen below, these stadia of *far* Forsk. show primary increase in the relative length of the ventrals, followed by recession, together with very considerable changes in the shape of the dorsal fin. In *knysnaensis* n. sp., on the other hand, no such changes with growth are observed; further, the triangular part of the upper jaw of *knysnaensis* is scaly, but naked in *far*. These two species may be regarded as subgenerically distinct, but until complete information on these points is available it would appear inadvisable to subdivide *Hemirhamphus* Cuv., and I do not here propose to attempt such a step, since it would serve no useful purpose as far as the South African species are concerned.

The South African species have received somewhat scant attention, and stood in need of critical revision. Two new species, *knysnaensis* and *improvisus*, are here described, and *balinensis* Blkr., which has not previously been recorded from our region, is now included.

Two species, *marginatus* Forsk. and *schlegeli* Blkr., which have been recorded from the neighbourhood of, but not strictly within the limits of, our region (after Barnard, Ann. S.A. Mus., 1925, xxi, p. 4, south of Mossamedes, west coast, and of Mozambique, east coast), are included, since with more intensive collection they are sure to be discovered here.

In South Africa the species of *Hemirhamphus* are generally known as

" Naald-vis " or " Needle-fish," also as " Half-beaks." They are of little or no economic significance, most of them being rather small and seldom taken in number. *far* is occasionally taken in moderate numbers by dragnets in the summer months, but is not generally in demand as a food-fish.

Terms employed in the Descriptions.

Since the beak and the caudal fin of preserved specimens are frequently damaged, the dimensional relationships are not here stated in total length only. The following limits are employed :—

Length of Body.—Measured from caudal base (v.i.) to tip of triangular part of upper jaw.

Length of Head.—Measured from hind margin of operculum to tip of upper jaw.

Length of Beak.—Measured from below tip of upper jaw to apex of beak.

Base of Caudal.—This is taken as the base of the mid-caudal rays, generally obscured by scales.

Lateral Rows of Scales.—Counted from above the hind margin of the operculum to caudal base, not including scales extending on to the caudal rays.

Lateral Line.—Figures indicate the number of scales bearing tubules, and the count is taken as follows, *e.g.* $\frac{4}{2+27+28}$, which indicates 4 from pectoral base down to junction, 2 from chest to junction, 27 from junction to ventral base, and 28 posteriorly from ventral base.

Key to the South African Species.

A. Upper jaw naked. Ventrals nearer base of caudal than base of pectoral.
  1. Black blotches on side. Body subquadrangular in cross-section, not very compressed . . . . . *far.*
  2. No blotches on side. Body fairly compressed . . . . . *marginatus.*

B. Upper jaw scaly. Ventrals inserted midway between base of caudal and base of pectoral, or nearer the latter.
  1. Mid-caudal rays not longer than eye. Caudal deeply forked. Dorsal scaly.
    a. 50–52 lateral rows of scales.
      Pectoral and ventral not scaly . . . . . *dussumieri.*
    b. 58–61 lateral rows of scales.
      Pectoral and ventral scaly.
        i. Beak 6·3 in total length. Preorbital 1·3 times longer than deep, not as long as eye . . . . . *delagoae.*
        ii. Beak 4–5 in total length. Preorbital 1·8–1·9 times longer than deep, as long as eye . . . . . *balinensis.*

2. Mid-caudal rays longer than eye. Caudal emarginate. Dorsal not scaly.
   a. Ventrals nearer hind margin of preopercle than base of caudal. Upper jaw wider than long, with 3–4 transverse series of scales, middle series over median ridge . . . . . *improvisus.*
   b. Ventrals nearer base of caudal than hind margin of preopercle. Upper jaw not wider than long, with 2 transverse series of scales, median ridge not covered by scales.
      i. Upper jaw longer than wide. 55–58 lateral rows of scales. South and east coasts . . . . . *knysnaensis.*
      ii. Upper jaw as wide as long. 50–53 lateral rows of scales. West coast . . . . . *schlegeli.*

Hemirhamphus far Forsk.

(Plate XII, fig. 1.)

1853. Bleeker, Nat. Tÿdschr. Ned. Ind., v, p. 89 (*fasciatus*).
1866. Bleeker, Atlas Ich., vi, p. 54, pl. vi, fig. 3.
1878. Day, Fishes of India, p. 516, pl. cxx, fig. 3.
1908. Gilchrist, Ann. S.A. Mus., vi, p. 266 (*commersoni*).
1913. Weber, Siboga-Exp. Fische, p. 131 (*fasciatus*).
1922. Weber and de Beaufort, Fishes Indo-Aus. Arch., iv, p. 157, fig. 55 and p. 158 (*marginatus*, juvenile=*fasciatus* Blkr.).
1925. Barnard, Ann. S.A. Mus., xxi, p. 262.

Adults.

Body elongate, robust, width 1·3–1·5 in depth. Sides scarcely convex, form, with almost flat ventral surface, a right-angled ventro-lateral edge. Depth 6–8, length of head 4·3–5·3, in length of body. Lower jaw 3–3·5 in body, 4·4–5 in total length. Eye 4–4·4 in head, 1·2–1·5 in snout, 1·6–1·8 in postorbital part of head, and 1·1–1·5 in interorbital width. Width of snout before eyes $\frac{7}{8}$ of its length. Head slightly depressed, interorbital gently convex, with 2 shallow longitudinal grooves. Top of head scaly to above nostrils. A slight medio-longitudinal ridge on the triangular part of the upper jaw, which latter is thick and fleshy, scaleless, and 1·3–1·9 times as wide as long. Width of lower jaw below tip of snout almost an eye diameter. Fairly stout tricuspid teeth in 3–4 rows in lower and 2–3 rows in upper jaw. Beak stout, cutaneous fringes about half the width of the beak: subgular sac prominent. Preorbital 1·3 times deeper than long, depth about half-eye diameter; covered by a single scale. Opercle with one large and two smaller scales. A single series of scales on the cheek, extending forward to below the corner of the mouth.

Gill-rakers 20–23, fairly stout, 3·5 in gill-filaments which are 1·5 in eye. Branchiostegals 12–13, membrane and mentum scaleless.

D 13–14, arises twice as far from base of caudal as from base of ventral. Anterior rays elevated, 3rd longest 1·7–1·9 in head, remainder decrease rapidly to the penultimate, which is about 9 in head, the fin having a deeply concave edge. The last ray is elongate, about 5 in head, with hinder branch free from membrane. Anterior fourth of fin densely scaled.

A 10–13, commences below the 6th or 7th dorsal ray. Anterior rays elevated, 3rd longest 2·5 in head, remainder decrease to the penultimate, which is about 9 in head, the fin having a gently concave edge. The hinder branch of the last ray is slightly longer than the preceding rays. Anterior third of fin densely scaled. Base of anal 1·6–2 in length of base of dorsal (rarely more than 1·8).

P 12, 1·3–1·7 in head, scaleless.

V 6, scaleless, 2·2–2·8 in head, inserted midway between base of caudal and almost the tip to distal fourth of pectoral. 1st and last rays longest, subequal, inner four rays graduated, shorter than 1st and last; last ray about 1·3 times the length of the penultimate.

Caudal deeply forked, upper lobe shorter, 1·3–1·4 in length of lower; mid rays shorter than or equal to eye.

Peduncle fairly robust.

Air-bladder cellular.

Scales.—Lateral rows 55–58, l.l. $\frac{3}{3+26-27+21-22}$, predorsal 37–39, 6–7 between dorsal and lateral line. Lateral line tubes highly arborescent ventrally (Plate X, A), more elaborated in anterior scales.

Colour.—Blue-green above, silvery below, dorsal scales light, with dark margin; opercle bronzy. Beak and membranes black, tip of beak red. A silvery-plumbeous stripe with blue upper margin from base of caudal along side curving gently over pectoral base and ending on shoulder: widest midway. 4–10 more or less distinct dusky blotches on side chiefly above lateral stripe. Dorsal, most of caudal, anterior part of anal, and ventrals, except last ray, dusky. Pectorals light. Ripe fishes usually have reddish blotches on the abdomen.

Length.—200–533 mm.

Locality.—Eastwards from False Bay, entering tidal rivers from Breede River, Port Beaufort to the Zambesi River, Rhodesia, occurring even in the Mazoe River, a tributary of the Zambesi, in fresh water miles from the coast.

Distribution.—Almost circumtropical.

Juveniles.

Very young specimens show considerable divergence from the adult form chiefly in the size and shape of the fins and of the jaws. The following

table indicates certain of the features of change with the growth of the fish:—

Total length (mm.) .	12	18	24	33	53	60	72	115	135	195	295	533
Depth in body . .	>10	>10	10	10	9	9	9	8·4	8	8	7	6·5
Head in body . .	ca. 4	ca. 4	4·5	4·5	4·5	4·5	4·8	4·8	4·8	4·3	4·5	4·9
Beak in total length .	None	ca. 20	9	6	5	4·5	4·8	4·4	4·4	4·3	4·6	5·0
Triangular upper jaw, wide as long . .	..	ca. 7	ca. 7	ca. 7	ca. 5	ca. 5	4	2·5	2·5	2·0	1·4	1·4
Eye in head . .	ca. 2	ca.2·5	3	3	3·2	3·3	3·3	3·5	3·7	4	4	4·3
Eye in snout . .	..	ca.0·4	ca.0·5	0·6	0·7	0·8	0·8	1·1	1·1	1·1	1·4	1·5
Eye in postorbital part head . . .	..	ca.1·3	1·5	1·6	1·5	1·7	1·7	1·7	1·7	1·7	1·7	1·8
Pectoral in head .	ca.1·5	ca.1·5	1·5	1·5	1·4	1·4	1·4	1·4	1·4	1·6	1·4	1·7
Ventral in head . .	ca. 4	ca. 3	2·0	1·8	1·6	1·6	1·7	1·5	1·6	2·0	2·4	2·8
Upper caudal lobe in lower . . .	ca.1·0	1·1	1·2	1·6	1·8	1·6	1·6	1·7	1·5	1·4	1·4	1·3
Shortest caudal rays in eye . . .	ca.0·5	0·7	0·7	0·8	0·8	0·8	0·9	0·9	0·9	1·0	1·1	1·1

Features which do not change appreciably with growth are the shape of the anal fin and the relative size and shape of the pectorals.

The Mouth and Jaws.

There is no prolongation of the lower jaw in fishes not exceeding 15 mm. in length: the adult proportions are attained when the total length is 50–60 mm. Fishes 100–200 mm. in length have relatively longer beaks than larger examples. (See above table.) The mouth is at first almost vertical and changes to nearly horizontal with the growth of the upper jaw, which commences only when the lower jaw is fully prolonged. Very young fishes have a single row of teeth, many of which are conical, though tricuspid teeth are observed at all stages: the number of rows increases with age.

Ventral Fins.

In very small fishes the ventrals are inserted midway between the base of the caudal and the middle to distal third of the pectoral. The point of insertion moves somewhat towards the caudal with growth of the fish. The ventrals are fairly small in the youngest stadia, increase in relative length until the fish is about 100 mm. in length, and thereafter decrease. In specimens 50–120 mm. in length the ventrals reach the base of the anal or beyond. The shape of the fin also undergoes modification: in fishes not longer than 60 mm. they resemble in shape that of the ventrals in an adult of the Exocoetid genus *Cypsilurus* Swnsn.: the 3rd ray longest, 1st shortest, 6th intermediate between 1st and 3rd, remainder graduated: the distal third of the fin being subacutely triangular in shape. With

growth of the fish, the 1st, 5th, and 6th rays increase in relative length, while the 3rd becomes shorter, so that when the fish is about 200 mm. in length, the 5th ray is longest, the 4th and 6th slightly shorter, subequal, 1st ray shortest. Further growth results in the change to the adult form in which the 1st and 6th rays are longest, subequal, the 2nd ray shortest, edge of fin concave.

Dorsal Fin.

When the length of the fish does not exceed 50 mm. the posterior dorsal rays are about twice as long as the anterior, and when laid back reach on to the caudal: the edge of the fin is straight. The relative length of the rays changes with growth: at about 100 mm. total length the anterior and posterior rays are subequal, the mid rays shorter, the anterior margin of the fin being concave: at about 150 mm. the anterior rays are 1·5 times the posterior, and the anterior part of the fin has the subfalcate shape of that of the adult. The posterior rays laid back no longer reach to the caudal. When the fish is about 200 mm. in length the shape of the fin approximates to that of the adult.

Coloration.

Very small fishes (35 mm.) are dusky green, with dendritic specks uniformly distributed over the body, approximating anteriorly to the scaling. Beyond this stage faint cross-bars appear, and with growth increase in density. In fishes exceeding 50 mm. in length there are 10 cross-bars on the body, one across the base of the caudal rays and a wide blotch over the distal portion of the lower caudal lobe: the caudal bars and the ventral portion of the bars on the side are rust-red in colour. The cross-bars on the body are prominent in fishes of 60–200 mm. in length, the ventral portion, and the caudal bars fading with growth.

In all but the smallest specimens the ventrals are black, the pigmentation retreating somewhat distally with growth, while the first ray becomes light. The dorsal and anal are at first almost wholly dark, the pigmented area retreating distally with growth, until in larger specimens the anterior part of each fin and a broad marginal band only are dark. The pectorals are uniformly unpigmented. The lateral stripe is not visible in specimens of less than 30 mm. total length. Fishes 50–100 mm. in length frequently have dark blue spots on the head. Beak and membranes black: tip of beak red in advance of mid-juvenile stage.

H. fasciatus Blkr. is undoubtedly the juvenile form of *far*. Weber and de Beaufort's diagnosis (*loc. cit.*) of *fasciatus* as juvenile *marginatus* Forsk. was evidently based upon the relative lengths of the bases of the anal and dorsal fins, which these authors state to be in *far* base anal 2 in base

dorsal, and 1·5–1·7 in *marginatus*. In our specimens of *far*, the base of the anal is usually 1·6–1·8 in the length of the base of the dorsal, occasional specimens showing 1·8–2. Our specimens show also further divergence from the usual diagnosis of *far*: the last ray of the ventrals and of the dorsal are elongate, longer than the penultimate; the number of scales in lateral series and the number of predorsal scales are greater: the anterior portion of the dorsal is more subfalcate in shape, while the body is not as deep nor the head as long as in specimens from other areas. It may be noted that the figures of Day (*loc. cit.*) and of Weber and de Beaufort (*loc. cit.*) are not strictly in accordance with the respective descriptions, while none of our specimens have the markedly fusiform body indicated in these figures, but are deepest across the middle of the pectorals, even fully ripe fishes.

I have examined several specimens from the Indo-Pacific and find that they have the base of the anal 1·8–2 in length of dorsal base and 51–55 lateral rows of scales. From the nature of the other features mentioned above, it would appear that most descriptions of *far* have been based upon old, preserved, and possibly damaged specimens.

Breeding Habits, Etc.

In the Knysna and neighbouring rivers specimens of *far* are first observed early in October, all ripe adults. The numbers increase rapidly, attaining a maximum in December and January. Ripe and spent adults are found until March, after which only a very occasional specimen is encountered, and none are present after the end of March. The young appear in November, become exceedingly abundant by January, and disappear entirely by March.

The eggs of *far* are demersal, 2·95–3·1 mm. in diameter, translucent, and provided with numerous glutinous filaments not longer than the diameter of the egg. The larger females produce about 12,000 eggs per season at Knysna. The breeding fishes, which appear to travel even beyond the tidal area in the rivers, congregate in shallow water over grassy banks, where two or more may frequently be seen slowly circling over a restricted area. In one case, two specimens so engaged were captured, and on examination, one, the larger, proved to be a ripe female, and the other a ripe male.

H. far may also be taken by allowing a fine line, baited with a small "shrimp" or "mud-prawn," to drift in the surface of the water: these larger specimens are exceedingly lively and provide most excellent sport on light tackle. The flesh is of fine texture and flavour, but is not generally esteemed on account of the presence of numerous fine bones.

Hemirhamphus marginatus Forsk.

1775. Forskal, Descr. Anim., p. 67.

1922. Weber and de Beaufort, Fishes Indo-Aus. Archip., iv, p. 157.

1928. Fowler, " Fishes Oceania," Mem. B. P. Bishop Mus., x, p. 78 (record only).

Body fairly compressed, width 2–3 in depth. Depth 5·3–6·5, length of head 3·7–4·2, in length of body. Lower jaw 3·3–3·5 in body, 4·5–5·1 in total length. Eye 3·8 in head, 1·3 in snout, 1·4–1·7 in postorbital part of head, and equal to or slightly greater than interorbital width. Head slightly depressed, interorbital gently convex, with 2 shallow longitudinal grooves. A slight medio-longitudinal ridge on the triangular part of the upper jaw, which latter is more convex above than in other species, and 1·3–1·5 times as wide as long, scaleless. Width of lower jaw below tip of snout slightly more than half an eye diameter. Tricuspid teeth in 2 rows in upper and 3–4 rows in lower jaw. Beak slender. Preorbital 1·2 times longer than deep, $\frac{3}{4}$ eye diameter in length. Single series of scales on cheek.

Gill-rakers 23, 2·3 in gill-filaments, which are 1·6 in eye.

D 13–14, arises 1·5–2 times as far from base of caudal as from base of ventral. Anterior rays elevated, about 1·9 in head, edge of fin deeply concave. Densely scaled anteriorly.

A 10–13, commences below the 6th dorsal ray. Anterior rays elevated, about 3 in head, edge of fin concave, last ray elongate. Scaly anteriorly. Base of anal 1·5–1·7 in length of base of dorsal.

P 11, 1·2–1·3 in head, scaleless.

V 6, scaleless, 2·6 in head, inserted midway between base of caudal and distal third of pectoral, first and last rays longest, subequal.

Caudal deeply forked, upper lobe shorter, 1·3 in length of lower; mid rays shorter than eye. Air-bladder at least partly cellular.

Scales.—Lateral rows 53–56, l.l. $\frac{3\text{–}4}{2\text{–}3+27\text{–}29+21\text{–}24}$, predorsal 34–38, 6 between dorsal and lateral line. Lateral line tubes arborescent ventrally. Arborescent muciferous canals on scales of head in some specimens.

Colour.—Blue-green above, silvery below. Plumbeous lateral stripe curving up over pectoral base. Beak and membranes black. Dorsal dusky, dark anteriorly. Caudal dusky, darker marginally. Pectorals and ventrals light.

Length.—Up to 350 mm.

Locality.—Gold Coast.

Distribution.—Almost circumtropical.

This species has not yet been recorded from within our area, but is

sure to be discovered on our eastern coast. I have examined specimens from the Indo-Pacific, and one specimen, loaned by the British Museum, from Accra. It is very closely related to *far*, from which it differs in the absence of the lateral blotches as well as in the highly compressed body, in the narrower interorbital, and in the fairly convex upper surface of the upper jaw.

Hemirhamphus dussumieri C. and V.

1846. Cuvier and Valenciennes, Hist. Nat. Poiss., xix, p. 33.
1925. Fowler, Proc. Ac. Nat. Sci. Phil., lxxvii, p. 203.
1925. Barnard, Ann. S.A. Mus., xxi, p. 263.

Body elongate, subcylindrical. Depth 9, head 4·5, in length of body. (Lower jaw 4–5·5 in body, 5–6·3 in total length.) Eye 4 in head, 1·5 in snout, 1·5 in postorbital part of the head, slightly less than interorbital width (slightly less than or equal to interorbital). Width of snout before eye $\frac{3}{4}$ of its length. Head moderately depressed, interorbital flat, scaled, three transverse series. A medio-longitudinal ridge on triangular part of upper jaw, which is 1·3 times as wide as long, scaly, 5 longitudinal and 3 transverse series of scales. Width of lower jaw below tip of snout $\frac{5}{8}$ of eye diameter. Small tricuspid teeth in fairly wide bands in both jaws. Beak stout, cutaneous fringes narrow, subgular sac small. Preorbital 1·5 times longer than deep, covered by a single scale. Two series of scales on cheek, scaling extends forward to below tip of snout. A single line of pores on chin. Opercle naked, scales evidently fallen off.

Gill-rakers 28, 3 in gill-filaments, which are 1·5 in eye.

D 15 (14–16), commences slightly nearer base of ventral than base of caudal. Anterior rays elevated, almost 3 in head; remainder decrease, edge of fin concave. Fin scaly.

A 15 (13–15), commences below the third dorsal ray. Similar in shape to dorsal. Fin scaly. Base of anal slightly less than base of dorsal.

P 11, 2 in head, not scaly.

V 6, not scaly, 3·3 in head, inserted midway between base of caudal and centre of opercle.

Caudal deeply forked, lower lobe longer. Mid rays $\frac{3}{4}$ of eye diameter.

Air-bladder simple.

Scales.—Lateral rows 52 (50–52), lateral line $\frac{3}{3+22+27}$, predorsal 33 (32–34), 6 scales between dorsal and lateral line.

Colour (preserved).—Light brown, evidently bright green-blue above, silvery below. Fins light. Numerous close-set blue spots on head and snout and in a mid dorsal line to the origin of the dorsal.

Length.—Up to 300 mm.

Distribution.—East coast of Africa, Indo-Pacific.

I have seen only one specimen of this species, from Aden, lent by the British Museum.

It would appear that a revision of this species is highly necessary, for not only do descriptions vary rather widely, but authors differ in the nominal species admitted as synonyms.

Day (Fishes of India, 1878, p. 515) includes *dussumieri*, described by Bleeker (Atl. Ich., 1866, vi, p. 56) in the synonymy of *reynaldi* C. & V. This is accepted by Weber and de Beaufort (Fishes Indo-Aus. Arch., 1922, iv, p. 155), who consider both synonyms of *dussumieri* C. & V., and who somewhat arbitrarily admit *erythrorinchus* le Sueur to the synonymy of *dussumieri* C. & V., but do not give expression to the admitted priority of the former name. Fowler ("Fishes Oceania," suppl., 1931, p. 319) considers *dussumieri* C. & V. a synonym of *erythrorinchus* le S.

Klunzinger ("Fische Rothe Meer," Verh. Zoo. Bot. Ges. Wien, 1871, p. 584) gives a description of *dussumieri* C. & V. which does not agree with many other descriptions of this species, as indicated by Day (*loc. cit.*), whereas Weber and de Beaufort accept it as *dussumieri* C. & V.

In my opinion, many specimens of *erythrorinchus* le S. have been described as *dussumieri* C. & V., but it would appear that this latter species may well be maintained as distinct from the former, provisionally differentiated by the presence of scales on the dorsal and anal fins, postorbital part of head more than 1·4 times eye, mid-caudal rays less than eye, and ventrals nearer head than caudal base.

Fowler's Delagoa Bay specimens (*loc. cit.*) are most probably *dussumieri* C. & V. (as here defined), although this author states the relation of neither the postorbital part of the head, nor of the mid-caudal rays, to the eye, while his specimens have D 13, and only 18 gill-rakers on the lower part of the anterior arch.

In so far as I am able to determine, *erythrorinchus* le S. does not fall within or near our area.

Hemirhamphus delagoae Brnrd.

(Plate XII, fig. 2.)

1925. Barnard, Ann. S.A. Mus., xxi, pl. x, fig. 6.

Body elongate, slightly compressed, sides scarcely convex. Width 1·25 in depth.

Depth 10, length of head 4·8, in length of body. Lower jaw 4·9 in body, 6·3 in total length.

Eye 3·8 in head, 1·4 in snout and in postorbital part of the head, slightly greater than the interorbital width. Width of snout before the eyes

about $\frac{2}{3}$ of its length. Head depressed, indications of scales on occiput. Slight medio-longitudinal ridge on triangular part of upper jaw, which latter is twice as wide as long, scaly, 4–5 longitudinal and 3–4 transverse series of scales. Width of lower jaw below tip of snout about $\frac{2}{3}$ of eye diameter.

Uni-, bi-, and tricuspid teeth present in anteriorly tapering bands, in 3–5 rows in each jaw, inner teeth mostly tricuspid, outer mostly unicuspid. Beak stout, cutaneous fringes $\frac{1}{3}$–$\frac{1}{4}$ as wide as beak; subgular sac moderate. Preorbital 1·3 times longer than deep, length 1·6 in eye, covered by a single scale with 2 central-branched pores. Three large scales with branched pores on opercle. 3–4 series of scales on cheek, scaling extends forwards to below the tip of the snout.

Gill-rakers 24, moderately slender, 1·3 in gill-filaments which are 3 in eye. Branchiostegals 12, membrane scaly. Mentum broad and densely scaled to symphysis, about 20 longitudinal and 4 transverse series of scales.

D 15, arises considerably in advance of midway between bases of caudal and ventral. Anterior rays elevated, 2·2 in head; remainder decrease, edge of fin concave. Densely scaled, heaviest anteriorly.

A 16, commences below the 2nd dorsal ray. Shape similar to dorsal, anterior rays about 2·5 in head. Densely scaled. Base of anal 1·25 in base of dorsal.

P 12, 1·8 in head. Base densely scaled, scaling extends over half the length of the fin.

V 6, scaled, densely on basal portion, length 3 in head. Inserted midway between base of caudal and base of pectoral. Anterior rays longest, last slightly longer than penultimate. Edge of fin concave. Caudal deeply forked, upper lobe 1·3 in lower. Mid rays slightly less than eye. Peduncle fairly stout.

Air-bladder simple.

Scales.—Lateral rows 61, l.l. $\frac{4}{2+27+28}$, predorsal 40, 6 rows between dorsal and lateral line. Lateral line tubes with numerous inferior tubules (Plate X, C).

Colour.—Greenish-blue above, silvery below. Nape, occiput, snout, and opercle dusky. Lower jaw and membranes black, tip of beak red. A narrow plumbeous lateral stripe from the base of the caudal to axil of pectoral, widest below origin of dorsal. Anterior dorsal rays dusky, remaining fins light.

Length.—295 mm.

Locality.—Delagoa Bay.

Type.—In the South African Museum (No. 12303).

The original description is inaccurate in many particulars, nor does the figure agree with the description.

This species is very closely related to *balinensis* Blkr., but differs in the shorter beak, in the size and shape of the preorbital, and in the much wider upper jaw. The eye is relatively larger in *delagoae* than in *balinensis*. It is an open question whether these differences alone justify the maintenance of *delagoae* as distinct from *balinensis*, the shorter beak of the former species being the only difference of note.

Fowler (Ann. Nat. Mus., vi, pt. 2, p. 250) considers that *delagoae* is identical with *unifasciatus* Ranz. The errors in the original description have evidently misled Fowler, for *delagoae* is well differentiated from *unifasciatus* by the position of the ventrals alone.

Hemirhamphus balinensis Blkr.

1858. Bleeker, Nat. Tŷdschr. Ned. Ind., xvii, p. 170.

1922. Weber and de Beaufort, Fishes Indo-Aus. Arch., iv, p. 152.

Body moderately compressed, width about 2 in depth. Depth 9–10, length of head 4·5, in length of body. Lower jaw 3·4 in body, 4·8–4·9 in total length. Eye 4·5 in head, 1·5–1·6 in snout, 1·6–1·9 in postorbital part of head, equal to the interorbital width. Width of snout before the eyes $\frac{2}{3}$ of its length. Head depressed, occiput scaly. Slight medio-longitudinal ridge on triangular part of upper jaw, which latter is 1·1–1·3 times as broad as long, scaly, 4–5 longitudinal and 3–4 transverse series of scales. Bi- and tricuspid teeth present in anteriorly tapering bands, in 3–4 rows in each jaw. Beak slender, cutaneous fringes narrow, subgular sac moderate. Preorbital 1·8–1·9 times as long as deep, as long as eye, covered by a single scale with 2 central pores. 2–3 series of scales on cheek, scaling extends forwards along sides of beak almost half-length of beak. Gill-rakers 22–26, slender, 2 in gill-filaments, which are about 2 in eye. Branchiostegals 12, membrane scaly. Mentum moderate, densely scaled to symphysis, about 20 longitudinal and 4 transverse series of scales.

D 15–16, arises considerably in advance of midway between bases of caudal and ventral. Anterior rays elevated, about 3 in head, remainder decrease to the penultimate, last ray elongate. Edge of fin concave. Densely scaled, anteriorly.

A 16–18, commences below the 2nd dorsal ray. Shape similar to dorsal. Densely scaled. Base of anal as long as base of dorsal.

P 12, base scaly. V 6, 3·5 in head, inserted midway between caudal base and hind margin to middle of opercle. Edge of fin concave. Base scaly. Caudal deeply forked, mid rays as long as eye, lower lobe longer.

Air-bladder simple.

Scales.—Lateral rows 61–64, l.l. $\frac{3}{3+28-29+28-29}$, predorsal 39–41, 6 between dorsal and 11. Lateral line tubes with numerous inferior tubules, resemble closely those of *delagoae* (see Plate X, C).

Colour (preserved).—Brown, darker above. Narrow dark stripe from base of caudal to axil of pectoral. Fins light.

Length.—Up to 220 mm.

Locality.—Mombasa.

Distribution.—Indo-Pacific.

The inclusion of this species in our fauna-list is based upon a specimen, lent by the British Museum, labelled *dussumieri* C. & V. from Mombasa. This specimen agrees generally with the diagnosis of *balinensis* Blkr., but differs in the rather light scaling on the vertical fins. Circumstances prevented a comparison of this specimen with two specimens of *balinensis* Blkr. subsequently kindly presented by Dr. de Beaufort, but there is little doubt that the Mombasa specimen is conspecific. The above description is based chiefly upon the two Indo-Pacific specimens.

Hemirhamphus improvisus n. sp.

(Plate XI, fig. 1.)

Body elongate, robust, slightly compressed, sides slightly convex, width 1·3 in depth. Depth 8·5, length of head 4·5, in length of body. Lower jaw 3·4 in body, 5 in total length. Eye 3·9 in head, 1·6 in snout, and in postorbital part of the head, 1·2 in interorbital width. Width of snout before the eyes 1·5 in length of snout. Head depressed, interorbital flat, with 2 shallow longitudinal grooves. No scales on occiput or interorbital, but these may have fallen off. Scarcely perceptible medio-longitudinal ridge on triangular part of upper jaw, which latter is slightly broader than long, scaly (fig. 1, B), 6–7 longitudinal and 3 or 4 transverse series: scaling extends over medio-longitudinal ridge. Width of lower jaw below tip of snout $\frac{3}{8}$ diameter of eye.

Tricuspid teeth in 5–6 rows in lower, and in 6–7 rows in upper jaw. Beak fairly stout, cutaneous fringes half as wide as beak; subgular sac moderate. Preorbital deeper than long, depth 1·8 in eye, a central pore indicating a scale, evidently fallen off. 2 large and 1 small scales on opercle. 2–3 series of scales on cheek, scaling extending forward on mandible to below middle of upper jaw. Gill-rakers 20, slender, 1·5 in gill-filaments, which are about 2 in eye. Branchiostegals 10: membrane naked; mentum narrow, naked.

D 14, arises very slightly in advance of midway between bases of caudal

and ventral. Anterior rays elevated, 4th longest about 2 in head; remainder decrease, edge of fin concave. Scaleless.

A 15, arises below 2nd dorsal ray. Similar in shape to dorsal, anterior rays slightly longer than longest dorsal rays. Fin scaly anteriorly and along base. Base of anal 1·2 in base of dorsal.

P 13, not scaled, 1·5 in head.

V 6, not scaled, length 2·6 in head, 2nd ray longest, 1st and 3rd equal, remainder decrease. Inserted midway between base of caudal and middle

Fig. 1.—Diagram to show type of scaling on upper jaws of *A. Hemirhamphus knysnaensis* n. sp. and *B. Hemirhamphus improvisus* n. sp.

of preopercle. Caudal slightly emarginate, mid rays 2·5 times eye. Lower lobe slightly longer than upper. Peduncle moderately slender.

Air-bladder simple.

Scales.—Lateral rows 53, l.l. $\frac{4}{2+22+25}$, predorsal 38, 6 rows between dorsal and lateral line. Lateral line tubes with 2–4 inferior tubules.

Colour.—Greenish above, silvery below. Nape, occiput snout, and top of opercle dark. Lower jaw and membranes black, tip of beak red. Median fins with dusky margins. A faint blotch on upper middle caudal rays. Remaining fins light. A silvery lateral stripe with dark upper border from base of caudal to axil of pectoral.

Length.—218 mm.

Locality.—Delagoa Bay.

Type in the South African Museum (No. 16368).

H. improvisus is closely related to *schlegeli* Blkr. and to *knysnaensis* n. sp., but is sharply distinguished from these by the character of the scaling on the triangular part of the upper jaw. In *improvisus* the middle of the 3 longitudinal series of scales is disposed centrally over the median ridge on the upper jaw, while the other two species have only 2 longitudinal series of scales which do not cover the median ridge (fig. 1, A and B).

H. improvisus is further distinguished from *schlegeli* and *knysnaensis* by the more anterior position of the ventrals and by the more obtuse upper jaw. The interorbital is markedly wider and the dorsal fin originates further back in *improvisus* than in *schlegeli* or *knysnaensis*.

Hemirhamphus knysnaensis n. sp.

(Plate XI, fig. 2.)

1916. Thompson, Mar. Bio. Rep., iii, p. 266 (*calabaricus*).
1925. Barnard, Ann. S.A. Mus., xxi, p. 262 (*calabaricus* part).
1929. Fowler, Ann. Nat. Mus., vi, pt. 2, p. 250 (*unifasciatus*).

Adults.

Body elongate, slender, slightly compressed, about 1½ times as deep as wide. Depth 9·3–10·9, length of head 4·3–5, in total length. Eye 4–4·3 in head, 1·5–1·6 in snout, 1·5–1·7 in postorbital part of the head, and subequal to the interorbital width. Width of snout before eyes about ⅔ of its length. Head depressed, with 2 shallow longitudinal grooves. Top of head scaly. Medio-longitudinal ridge on triangular part of upper jaw, which latter is slender, 1·1–1·3 times longer than wide, scaly, 4–5 longitudinal and 2 transverse series of scales: scales not overlapping medio-longitudinal ridge (fig. 1, A). Width of lower jaw below tip of snout about half-eye diameter. Minute curved conical teeth (unicuspid) in 2–3 rows in lower and 3–4 rows in upper jaw; a few tricuspid inner teeth in larger specimens. Beak slender, cutaneous fringes as wide as beak; subgular sac small. Preorbital slightly longer than deep, less than eye, covered by a single scale with central pore. Opercle with one small and two large scales. 2 series of scales on cheek, scaling extends forward along side of mandible about an eye diameter beyond below the tip of the snout.

Gill-rakers 25–28, slender, 2 in gill-filaments, which are slightly longer than 2 in eye. Branchiostegals 10, membrane and mentum scaleless.

D 16–17, arises considerably in advance of midway between bases of caudal and ventral. Anterior rays slightly elevated, 3rd longest, about 3 in head; remainder decrease to the last, which is about 5 in head.

Edge of fin slightly concave. Scaleless.

A 16–18, commences below the 2nd or 3rd dorsal ray. Shape similar to that of dorsal. Length of base slightly less than that of dorsal. Scaleless, or few basal scales in large examples.

P 11, conspicuously short, 1·8–2 in head. Scaleless.

V 6, scaleless, about half the length of the pectoral, inserted midway

between base of caudal and base of pectoral to hind margin of operculum ; usually nearer base of caudal than hind margin of head. Anterior rays longer.

Caudal moderately forked, upper lobe shorter, 1·2 in lower : mid rays 1·6–2 times eye. Peduncle slender.

Air-bladder simple.

Scales.—Lateral rows 55–58, l.l. $\frac{3}{3+26-28+22-24}$, predorsal 34–35, 5–6 rows between dorsal and lateral line. Lateral line tubes with one to four inferior tubules (Plate X, B).

Colour.—Blue-green above, silvery below. Nape, occiput, snout, and opercle dusky. Beak and membranes black, tip of beak red. A narrow, plumbeous lateral stripe from upper edge of pectoral base to base of caudal, broadest (2 in eye) below origin of dorsal. In ripe males this stripe extends on to and over the lower caudal lobe. Anterior portion of dorsal dark, lighter posteriorly. A dark spot at the base of each dorsal and anal ray. Caudal with marginal area dusky. Remaining fins light.

Length.—95–220 mm.

Distribution.—South and east coasts of Africa. From False Bay to Natal, entering rivers, extending into fresh water.

Types from Knysna in the Albany Museum.

Juveniles.

The young of this species are very slender and show main divergence from the adult form in the extent of the prolongation of the lower jaw and to a lesser extent in the shape of the caudal. The dorsal, anal, and pectoral fins approximate throughout in size and shape to those of the adult. The ventral fins are scarcely visible in very small specimens (< 12 mm.), but thereafter rapidly attain and remain at the adult proportions.

When 7 mm. in length the young are transparent, with a few dusky specks on the dorsal surface. The mouth is very oblique, the lower jaw not prolonged, and the triangular part of the upper jaw many times wider than long. The caudal is symmetrical, almost truncate, and there is no trace of the lateral stripe. The lower jaw is first observed to project when the fishes exceed 10–12 mm. in length, and thereafter increases rapidly in relative length, the proportions of the adult in this feature being attained when the total length of the fish exceeds 30 mm.

The relative increase in the length of this feature is shown on p. 146.

At 10–12 mm. length the specks on the body are darker, and the first signs of the lateral stripe are seen as a series of short, dark longitudinal

Total length of specimen (mm.).	Lower jaw in total length.
16	16
20	10
23	6·6
27	5·5
31	5·0
33	4·6

lines. The lower caudal lobe is now the longer. The lateral stripe is visible as such in specimens exceeding 20 mm. in length, and the caudal is markedly asymmetric. The mouth becomes less oblique, and the prolongation of the upper jaw commences when the length exceeds 25 mm. At about 30 mm. total length the triangular upper jaw is about 4 times wider than long; at 70 mm. it is almost as long as wide; at 80–100 mm. as long as wide; thereafter gradually more acute, until in specimens over 200 mm. in length it is as much as 1·3 times longer than wide. At all stages the beak is black, the red tip appearing in the later juvenile stages.

This species is closely related to *schlegeli* Blkr. and *improvisus* n. sp., from which it is distinguished by the more acutely triangular part of the upper jaw as well as by the greater number of scales in a lateral series, and of dorsal and anal rays.

It is also related to *georgii* C. & V., from which it differs in the shorter beak, as well as in the more anterior position of the ventrals and in the greater number of dorsal and anal rays.

The two specimens from False Bay, very inadequately described by Fowler (*loc. cit.*) as *unifasciatus* Ranz, are most probably *knysnaensis*.

Breeding Habits, Etc.

H. knysnaensis appears to be present in the tidal rivers of South Africa throughout the year, extending into fresh water. Ripe fishes are first encountered in October and are most numerous in November and December. The young are exceedingly abundant in these months, and are present until February, after which they disappear. It is curious that the ripe fishes of this species have not been observed to congregate in any special areas, but are encountered in the surface of deep as well as shallow water, from two to four swimming one behind the other. Females predominate markedly in number.

The eggs are demersal, 1·6 mm. in diameter, almost transparent, and densely covered with glutinous hair-like filaments, considerably longer

than the diameter of the egg. The larger females produce about 10,000 eggs per season.

Hemirhamphus schlegeli Blkr.

1862. Bleeker, Mem. Soc. Holl. Haarlem, p. 120, fig. 1.
1866. Gunther, Cat. Fish. Brit. Mus., vi, p. 266 (*calabaricus*).
1866. Gunther, Ann. Mag. Nat. Hist. (3), xviii, p. 427 (*calabaricus-schlegeli* Blkr.).
1925. Barnard, Ann. S.A. Mus., xxi, p. 262 (*calabaricus* part).

Body elongate, subcylindrical, about $1\frac{1}{4}$ times as deep as wide.

Depth 9–9·4, length of head 4·4, in length of body. Lower jaw 3·3–3·6 in body, 5–5·2 in total length. Eye 3·8–4 in head, 1·2–1·3 in snout, 1·5 in postorbital part of the head and subequal to the interorbital width. Width of snout before eye $\frac{3}{5}$ of its length. Head depressed, interorbital flat, with 2 shallow longitudinal grooves, scaly, 3 transverse series. Medio-longitudinal ridge on triangular part of upper jaw, which latter is slender, as long as wide, scaly, 3–4 longitudinal and 2 transverse series of scales, not overlapping median ridge. Width of lower jaw below tip of snout about half eye diameter. Small conical, bi- and tricuspid teeth in 3 rows in each jaw. Beak slender, cutaneous fringes almost as wide as beak; subgular sac small. Preorbital almost as deep as long, covered by a single scale with central pore. Three series of scales on cheek, scaling extends forward to below corner of mouth; a single line of pores on the side of the chin.

Gill-rakers 22–26, slender, 2–3 in gill-filaments, which are about 1·5 in eye. Branchiostegals 10, membrane scaleless.

D 14, arises considerably in advance of midway between bases of caudal and ventral. Anterior rays slightly elevated, 3rd longest, 2·5 in head, remainder decrease, last 5 in head. Edge of fin gently concave. Scaleless.

A 15–16, commences below 2nd dorsal ray. Shape similar to dorsal; slightly higher than dorsal. Length of base slightly less than that of dorsal. Scaleless.

P 11, 1·7–1·8 in head, scaleless.

V 6, scaleless, half the length of the pectoral, inserted midway between base of caudal and hind margin to middle of opercle. Anterior rays longer.

Caudal emarginate, upper lobe shorter, 1·3 in lower. Mid rays 1·5–1·7 times eye. Peduncle slender.

Scales.—Lateral rows 50, l.l. $\frac{4}{2+24+22}$, predorsal 35, 6 rows between dorsal and lateral line. Lateral line tubes with 2 or 3 inferior tubules. Air-bladder simple.

Colour (preserved).—Brownish yellow, darker above. A dark lateral stripe from base of caudal to axil of pectoral, widest below origin of dorsal.

Anterior dorsal rays and margin of caudal dusky. Remaining fins light. Beak black.

Length.—140–215 mm.

Locality.—Angola, Cameroons.

Distribution.—West coast of Africa.

This species does not strictly belong to the South African fauna, but is included here since it is almost certain to be discovered within our region.

Fowler (Ann. Nat. Mus., 1929, vi, pt. 2, p. 250) considers *schlegeli* identical with *unifasciatus* Ranz. This is scarcely possible, since this latter species has a very short beak, ventrals inserted midway between caudal base and eye, and dense scaling on the dorsal and anal fins.

Notes on the Hemirhamphidae.

These fishes appear to live almost exclusively in the surface of the water, and show high specialisation of habit with adaptive modifications in external form.

The leaping powers of the species of *Hemirhamphus* are markedly characteristic. These fishes emerge from the water with the body rigidly straight, and the leap is terminated either by falling flat upon the surface, or, in the case of the smaller specimens, with the caudal first entering the water. I have not yet seen any of these fishes ending a leap by diving head first into the water. The ventrals are fully extended laterally during the leap. As many as six or seven immediately consecutive leaps have been observed, the pause between each for renewal of the impulse being extremely brief. Adult specimens of *H. far* cover 10–15 feet in each leap, and are able to progress up to 100 feet along the surface in this manner, at an average speed of at least 25 feet per second. Very young specimens of this species are apparently unable to emerge from the water and are very easily captured, even by day. *H. knysnaensis*, a smaller species, progresses in a similar fashion along the surface, but the body is held at an angle of about 45° to the surface, the leaps are very short, 1–2 feet, and are seldom repeated more than 4 or 5 times. Half-grown specimens of this species show an interesting stage in the development of this power. When startled, these fishes shoot up until the body as far as the ventrals is out of the water at an angle of about 45° to the surface: with ventrals widely extended, the body is held in this position, and urged forward along the surface for a few yards at a surprising rate, the caudal vibrating with extreme rapidity. As far as has been observed, none of these fishes, small or large, attempt to escape attack, even from above, by diving, which would appear to indicate that they do not readily sink from the surface for any purpose.

The leaping powers of these fishes have led Schlesinger (Phy. and Eth. d. Scombr., Verh. Zoo. Bot. Ges. Wien, 1909, lix, pp. 302–339) to conclude that the closely related *Exocoetidae* have developed from the *Hemirhamphidae*. It would appear more reasonable to suppose that both forms have developed simultaneously from a common surface-dwelling ancestral type, the enlargement of the " beak " of the *Hemirhamphidae* and the pectorals of the *Exocoetidae* representing later specialisation. The very young stages of species of *Hemirhamphus* have no " beak," while the pectorals of the very young of certain species of the *Exocoetidae* are relatively considerably less elongate than those of the adult fishes.

The adoption of a purely surface life in the case of the *Hemirhamphidae* (and of the *Exocoetidae*) is further indicated by the ventro-lateral position of the lateral line in these fishes.

Functions of the " Beak."

Schlesinger (*loc. cit.*) has concluded that the prolonged lower jaw of the *Hemirhamphidae* is employed to plough up the bottom mud in search of food, and he discounts the statements of other investigators that the stomach contents of these fishes consist solely of surface plants and organisms.

It has been previously indicated that there are reasons for believing that the *Hemirhamphidae* are exclusively surface-dwellers. I have examined microscopically the stomach contents of many specimens of various species of *Hemirhamphus*, and it is significant that in no case was any trace of sand-particles observed. The aliments generally appear to consist of surface plants, larval crustacea and fishes, and pelagic eggs. The *Mugilidae* are also surface-dwellers, but feed not only upon surface organisms, but also upon material obtained by skimming or stirring up the bottom mud and eel-grass (*Zostera*) in shallow water ; sand particles are invariably present in the aliments of the *Mugilidae*, frequently in large proportions. It appears inconceivable that the *Hemirhamphidae* could eliminate all trace of sand particles from food obtained by stirring up mud with the beak.

Further, the tip of the beak of a live *Hemirhamphus* is soft, and the distal portions of the lateral cutaneous fringes extremely delicate and fairly vascular. These fishes rapidly succumb when the beak is damaged, and it is perhaps significant that among many hundreds of specimens I have taken alive none have been found with a broken beak. It would therefore appear extremely unlikely that the " beak " is employed in the manner suggested by Schlesinger.

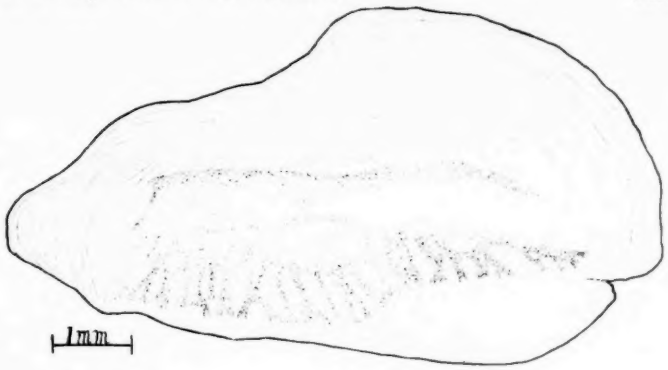
From sustained observations, chiefly by night with the aid of a powerful light, it appears not unlikely that the prolonged lower jaw, with its cutaneous

fringes, is employed by these fishes as an organ for the detection of the minute surface organisms which constitute their food. They lie in the surface of the water with the cutaneous fringes of the beak fully extended laterally. At frequent intervals the head may be seen to be jerked slightly to one side, the body urged forward, and motions concomitant with the assimilation of some particle ensure. Specimens will lie undisturbed in the light of a lamp, if cautiously approached; the body may be touched with a very fine wire without occasioning undue alarm, but if the beak is only lightly touched, the fish withdraws violently.

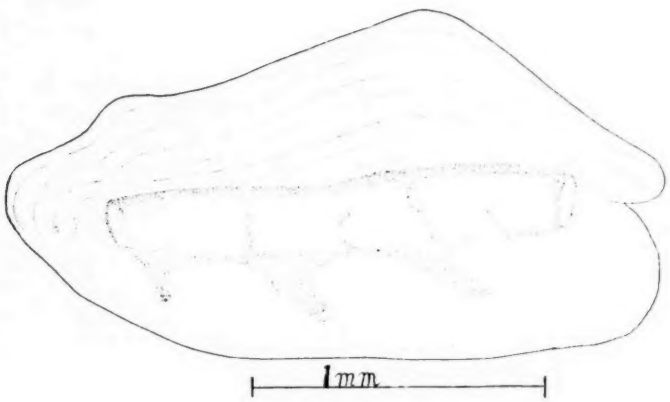
The function of the subgular sac remains obscure. The contents of the distended sac (rarely so observed after capture) appear to be liquid, and not gaseous, but sufficient could not be obtained for investigation.

I wish to express my gratitude to Mr. J. Hewitt, Director of the Albany Museum, and to Dr. K. H. Barnard, Assistant Director of the South African Museum, for advice and assistance, and for the loan of material and literature; to Mr. J. R. Norman of the British Museum for the loan of, and to Professor de Beaufort of Amsterdam, for the donation of, valuable specimens. Also for financial assistance from the Carnegie fund, through the Research Grant Board of South Africa, which defrayed part of the costs of the investigation.

Albany Museum,
Grahamstown.



A



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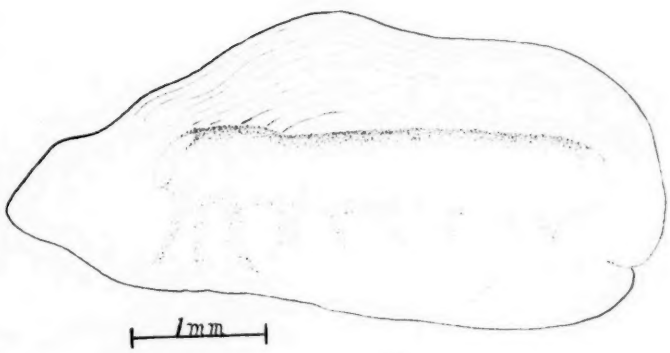
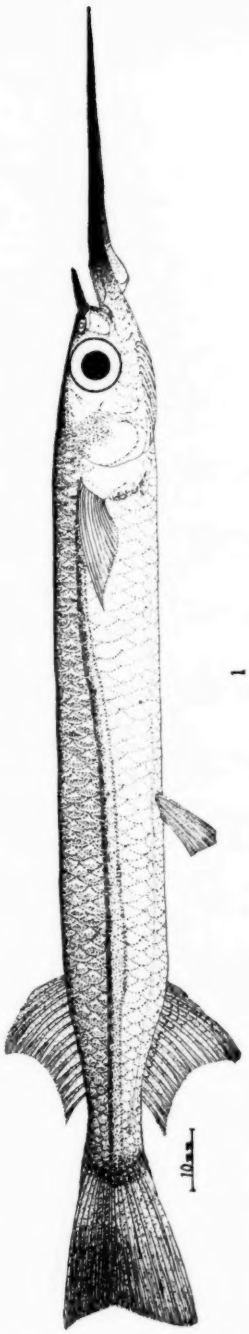


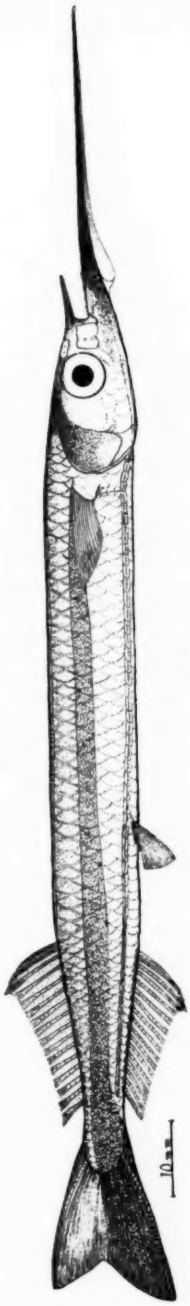
C

LATERAL LINE SCALES, SEMI-DIAGRAMMATIC.

A, *Hemirhamphus far* Forsk.
B, *Hemirhamphus knysnaensis* n. sp.
C, *Hemirhamphus delagoae* Brnrd.



1



2

1. *Hemirhamphus improvisus* n. sp.
2. *Hemirhamphus knysnaensis* n. sp. (male).

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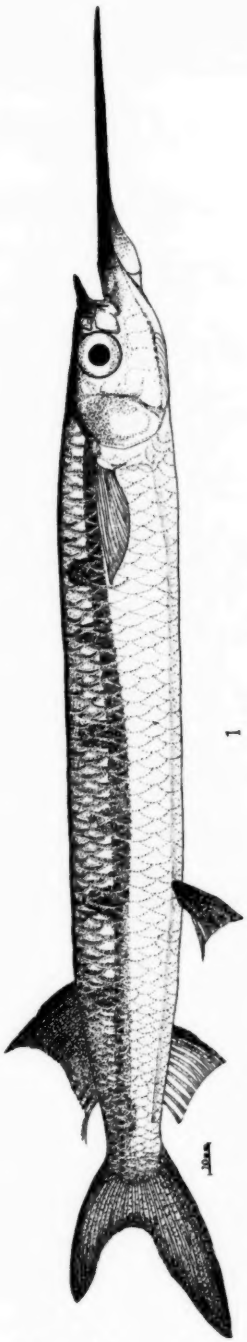

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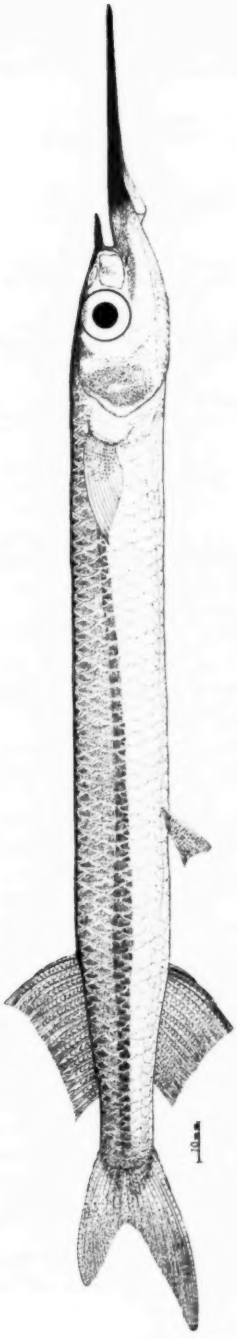


2

1. *Hemirhamphus far* Forsk.
2. *Hemirhamphus delagoae* Bmrd.

J. L. B. Smith. *Neill & Co., Ltd.*

A DESCRIPTIVE ACCOUNT OF THE HUMAN SKULLS FROM MATJES RIVER CAVE, CAPE PROVINCE.

By Sir Arthur Keith.*

(With thirty-three Text-figures. Reduced to one-third.)

Skull M.R. (1) 30 *feet.* (See figs. 1, 2, 3, 4.)

The imperfect skull of a young adult male probably between twenty and twenty-five years of age, all the sutures being still freely open. The three molar teeth are in full use—the cusps being worn so as to expose the dentine of the crowns at their bases. The sutures are simple—as will be seen from the illustrations.

The face—save the left half of the lower jaw—is missing; so is the glabellar region of the forehead; the base also is lacking. Outwardly the bone has a brown colour; the broken surface is of a chalky grey. The skull comes from the deepest occupation level of the site—namely, from a depth of 30 feet. The cultural objects at this level were of the Mossel Bay type. The skull represents the people who carried on this culture. The discovery reveals for the first time the kind of people responsible for that culture.

Racial Nature.—Before describing this skull, it may be well to touch on the conclusions I have reached regarding the racial nature of this man. He represents a prehistoric type of humanity we know of only in South Africa. A generic name is needed to cover all the varieties or breeds of the generic type. In the meantime I shall speak of it as the prehistoric type of South Africa. The known representatives of the type are the Boskop people, the Bushman—modern and prehistoric, the Strandloopers, the Hottentots and Matjes River people. All of these have certain characters which link them together and mark them off from other basal stocks of modern (neanthropic) man. These characters I will enumerate as I proceed with my description. On the evidence at present available it seems most probable that the prehistoric type of South Africa has come into being south of the Zambesi, and that in the course of time local races have arisen. The man whose skull I am to describe I suppose to represent one of these local breeds or races.

* The drawings of the skulls were made by Mr. Ernest Smith, R.C.S.

Although the glabellar region has been broken away, yet enough of the lateral brow region is left to give an approximate estimate of the original length—glabello-occipital length—which I estimate at 193 mm.; the maximum width—which is in the lower parietal region—is 135 mm., the width being 70 per cent. of the length—a dolichocephalic skull. The vault rises 114 mm. above the Frankfort plane (fig. 1). We are thus dealing with a long-headed race with a brain falling into the medium class (between 1350 c.c. and 1450 c.c.); in this example the Lee-Pearson formula gives a cranial capacity of 1400 c.c.

When we look at this skull from above (fig. 3) we are at once struck by the narrowness of the frontal region and also by the fact that the upper or tabular part of the frontal bone appears as if it had been compressed from side to side. The maximum width of this bone is only 103 mm., 22 mm. less than the parietal width. The minimal frontal width, which can be estimated from fig. 4, is only 90 mm., while the width at the supra-orbital processes—the left of which is preserved—is 102 mm., almost equal to the maximum frontal width. Now this narrowness, and especially the appearance of lateral frontal compression so apparent in this skull, are features we are to meet with in other skulls from this site and demands explanation.

In the Museum of the Royal College of Surgeons of England there are five skulls illustrating the developmental abnormality to which the name trigonocephaly has been given—such skulls being triangular in their outline when looked at from above, the forehead forming the apex of the triangle. The maldevelopment is of the same nature as that seen in scaphocephalic (boat-shaped) skulls. In scaphocephaly there is a premature union of the sagittal suture, leading to early fusion of the right and left parietal bones. In trigonocephaly there appears to be a premature arrest of growth of the two halves of the frontal along the median frontal or metopic suture. The skull here described shows a moderately developed stage of trigonocephaly. The condition is of interest because of its not infrequent appearance—to a slight degree—in the skulls of the South African stock. It is seen occasionally in modern Bushman skulls. In the Museum of the Royal College of Surgeons of England there are skulls of both Bushmen and of Hottentots which were collected between 1854–1861 by Sir George Grey when High Commissioner for South Africa. Two of the Bushmen skulls show a slight degree of trigonocephaly. There are two features of this condition: (1) a median elevated ridge which begins on the lower forehead and is traceable back to the bregma; besides the presence of the median frontal ridge there is (2) a slight development, or complete absence of the frontal bosses or eminences. In M.R. (1) there are no bosses and the median ridge is pronounced. In the original Boskop skull the bosses are pronounced and the median ridge is only slightly

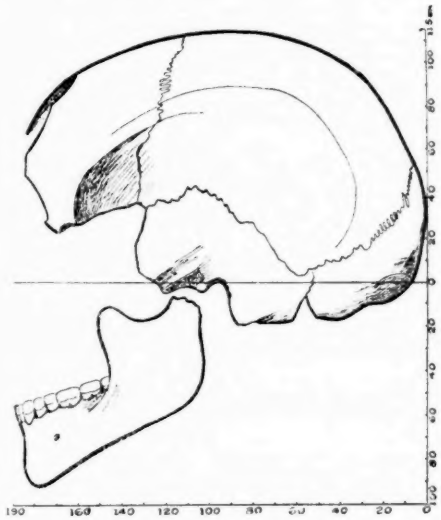


FIG. 1.

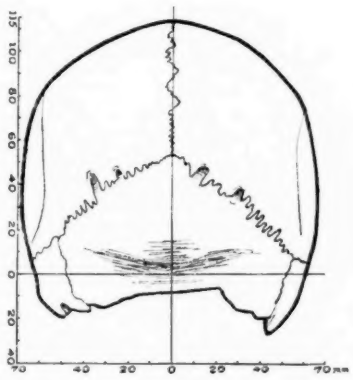


FIG. 2.

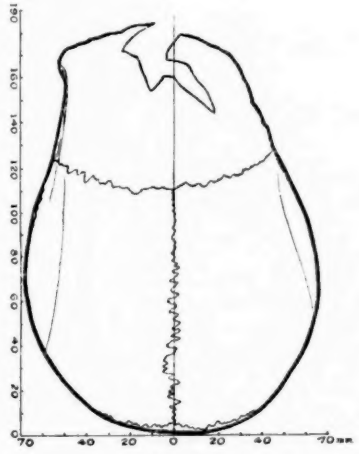


FIG. 3.

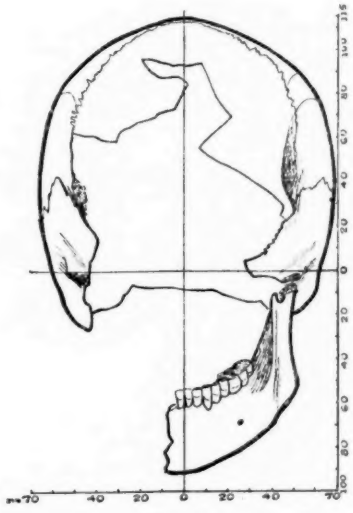


FIG. 4.

Skull M.R. (1).

indicated. In order that a numerical expression may be given to the degree of ridging, I have used the following method. As is shown diagrammatically in fig. 5, two sections are traced across the frontal bone, one section at a point in the median line 35 mm. in front of the bregma, and the second at 70 mm. in front—which point usually lies between the sites of the frontal bosses. Such sections are shown in fig. 5. They extend to 35 mm. on each side of the midline. The terminal points of the sections are represented by *A.A.* in the upper tracing of fig. 5, and by *B.B.* in the lower tracing; these points *A.A.* and *B.B.* are connected by base-lines which are of course 70 mm. long. The ridging is estimated by the distance

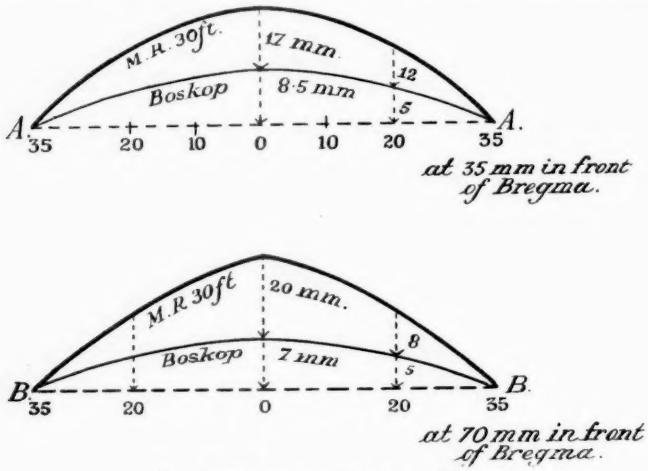


FIG. 5.—Sections across the frontal bone.

to which the transverse arc of the frontal rises above the base-line—measurement being made at right angles to the median frontal arc. In the upper section, made 35 mm. in front of the bregma, the transverse contour of M.R. (1) is compared with the corresponding contour taken from a cast by the Boskop skull. The height of the frontal arc in M.R. (1) is 17 mm., in Boskop 8·5 mm. In the lower section the height of the transverse frontal arc is 20 mm. in M.R. (1) against 7 mm. in Boskop. Between these two degrees of curvature—the flat frontal represented by Boskop and the high degree of arching in M.R. (1)—we shall find a series of intermediate stages in the skulls from Matjes River Cave.

We come now to the first of the characteristic traits of the prehistoric South Africa type. This trait is the peculiar shelf-like development of the external or supra-orbital part—as distinguished from the supraciliary

part—of the supra-orbital ridge. It is difficult to invent a method of measuring the characteristic form of the Boskopoid supra-orbital angular process of the frontal; but it is readily recognisable. Both supraciliary (internal) and supra-orbital (external) parts run into each other to form a horizontal bony shelf, which is separated from the ascending tabular part of the frontal by a deep groove or constriction. This groove, beginning in the supraglabellar depression, passes laterally towards the temporal region separating the external angular process from the region of the frontal boss. The length—or degree of development of the external angular process—may be measured in the following way. The base of the process lies along the frontal constriction or depression just mentioned; its apex is at the fronto-malar suture. The length of the process—from base to apex, can be measured by a tape passing from base—in the middle of the groove—to the fronto-malar suture. In M.R. (1) this measurement is 31 mm.; in the Boskop skull, 28 mm.; in the prehistoric Bushman from Skildergat Cave, 21 mm. The width of the external angular process—measured from orbital to temporal margin—just above the fronto-malar suture, is great in prehistoric South African skulls. In M.R. (1) it measures 15 mm., almost the same as in the Boskop skull; in the above-mentioned Bushman it measures 14 mm.; in modern Bushmen 10 mm. is a common amount.

Another way of measuring lateral supra-orbital development is to compare the supra-orbital width of the frontal with the minimal width. In M.R. (1) the supra-orbital width exceeds the minimal width by 12 mm.—which is a large amount—5 or 6 mm. being the usual excess in Bushman skulls.

Another feature which occurs more frequently in South African skulls than in those of any other stock is represented by the course taken by branches of the supra-orbital nerve. These nerves, instead of escaping by a groove, notch or marginal foramen at the upper border of the orbit, pursue a deep course on the bone and appear in grooves which ascend the lateral part of the frontal bone. In a series of 53 Bushman skulls from Colesberg, Mr. D. Slome found that the deep or buried course was present in 50 per cent. of his specimens (Annals of S.A. Museum, 1929, vol. xxiv, p. 33). In M.R. (1) the deep course is exemplified; it is also so in the Boskop skull and in many of the others from the Matjes River Cave. This aberration in the course of the frontal nerves was described by Professor Francis Dixon (Journ. of Anat., 1900, vol. xxxv, Appendix, p. li). Professor Dixon found that the frontal nerves take a deep course in 50 per cent. of Negro skulls. This feature occurs more frequently in native African races than in any other racial stock.

We now turn to another part of the M.R. (1) skull—one concerned in

the fixation of the head to the neck—the mastoid and occipital regions. The width of the skull measured over the bases of the mastoid processes is 120 mm.—15 mm. less than the maximum width of skull—indicating a moderate width of neck. In the various breeds of the South African type the mastoids are slightly developed—often, especially in females, exposing the diagastric fossa. The low development of the mastoid is one of the many tendencies in this stock towards the retention of infantile or juvenile characters. There is no accepted manner of expressing the development of the mastoid process; the best I know is to measure the distance which its apex descends below the Frankfort plane (see fig. 1). In M.R. (1) it descends 19 mm., which may be described as less than a moderate development. The ridges on the occipital bone for the attachment of the neck-muscles are mere impressions; the inion itself scarcely rises above the neighbouring surface of the bone. But the neck was deep from back to front, the inion lying 87 mm. behind the porion—mid-point of upper margin of ear-passage. The most prominent point of the occiput is 96 mm. behind the vertical plane of the porion—9 mm. more than the inion. This gives a measure of occipital projection. The glabella lies about 97 mm. in front of the vertical meatal plane, so that in this skull pre-auricular and post-auricular lengths are almost equal.

All the face is missing save the left half of the lower jaw. This, however, tells us much we want to know. One of the most characteristic features of the South African stock is the lower jaw—particularly its ascending ramus—to which the muscles of mastication are attached. The most striking of these measurements is the minimal width of the ascending ramus; in this skull it measures 42 mm.—a very high amount, indicating great development of the chewing muscles. Equally striking are the height measurements of the ascending ramus; the minimal height, taken from the lower border to the bottom of the sigmoid notch, is 43 mm.—almost the same as the minimal width. The square form of ramus is characteristic of the South African—particularly of the Bushman stock. The heights of the coronoid process and mandibular process are 56 mm. and 63 mm. (?) respectively. The body of the mandible—the tooth-bearing part—of the South African mandible is remarkable for its shallowness (measured from alveolar to lower border) and for its thickness measured from side to side. At the 2nd molar the depth of the jaw is 24 mm.; its thickness 19 mm. At the symphysis the height is 34 mm.; its thickness (back to front diameter) 17 mm.—all of them characteristic of the prehistoric South African type. The mental foramen lies below the interval between first and second premolar teeth. On the lingual aspect of the symphysis are all the features which Professor Arthur Thomson (Journ. of Anat., 1916, vol. l, p. 53) observed in the jaws of Bushmen—a genial pit, below

which are impressions, or rather slight tubercles—for the attachment of the genio-glossal muscles ; a median impression below these for the genio-hyoid muscles ; on the under surface of the symphysis wide and well-marked impressions for the digastric muscles.

The teeth are relatively small, as is usual in peoples of the South African stock. The total length of the three lower molars is 31 mm.—the first being 11 mm., the second rather more than 10 mm., the third rather less. In modern Bushmen (Colesberg) Professor Drennan (Annals of S.A. Museum, 1929, vol. xxiv, p. 69) found that the mean lengths for the 1st, 2nd and 3rd lower molars were : 10·9, 10·6, 9·9 = 31·4 mm. The Matjes River people, however, were not dwarfs, but of medium height.

The chin in South African peoples has a uniform development : it is a triangular, low, rounded elevation—its base below about 35 mm. wide and its apex above about 25 mm. high. For many years I have been accustomed to measure chin development thus : I lay the mandibile resting on its lower border upon millimetre paper, its condyles being pressed against a block which rises vertically from the millimetre paper. The vertical block, set along the zero line represents the vertical condylar plane. When the mandible of M.R. (1) is arranged thus its chin projects 108 mm. in front of the vertical plane ; its median, incisor alveolar border 101 mm. The difference between chin and alveolar projection represents chin development, in this case 7 mm. which, for South Africans, is a good development. The forward reach of the chin (108 mm.) is a large amount. The great length of the body is also indicated by the measurement of its outer circumference. This measurement is made by tape from the mid-point of the symphysis, along the outer surface, midway between the alveolar and lower borders, to the hinder border of the ascending ramus. In M.R. (1) this measurement reaches 111 mm.

From the projections represented in fig. 4 it will be seen that the angles of the mandible were everted and that the biangular (bigonial) width must have been about 104 mm., indicating a wide-jowlled person. The bicondylar width must have been only slightly more—108 mm.—the ascending ramus being almost vertical in its lateral ascent. Further, the bizygomatic width could not have been much over 120 mm. Although the cheek-bones of South African skulls are prominent in a forward direction they are not prominent laterally, the bizygomatic width being usually low. In the Skildergat prehistoric Bushman, however, the bizygomatic width was 136 mm.

One or two points relating to the development of the masticatory impressions on the sides of the skull are worthy of note. In the Boskop skull, as is well known, the temporal ridge above the base of the mastoid process and above the ear had a pronounced development. In M.R. (1)

the supramastoid ridge is slightly developed. Nor did the temporal muscles, as indicated by the temporal lines, have an extensive development on the parietal bones. The muscular ridge rises 88 mm. above the upper border of the zygoma, the fascial ridge 94 mm., these measurements being taken 20 mm. behind the coronal suture.

I am entering rather fully into matters of detail regarding this skull, M.R. (1). It is to serve as a basis for the description of others from the same site. The outline of the skull, as seen in profile (fig. 1) and in hind view (fig. 2), offers nothing characteristic of race; yet the form of the suture between the temporal and parietal bones and the parieto-occipital outline are more suggestive of the South African stock than of any other. As, however, the curvatures of the bones forming the vault of the skull and the relative length of the various bones—frontal, parietal and occipital —provide means of racial identification, I must add here notes on these points. In the ancient skull now under review, the length of the arch of the frontal bone from nasion to bregma I estimate to have been 130 mm.; the parietal arch, from bregma to lambda, 135 mm. Seventy mm. of the occipital arch is preserved; the impression for the inion lies 46 mm. below the lambda. A description of the curvature of each bone and the length of the line which joins the extremity of each arch will be given later.

As to thickness of the vault: at the inion the bone is 13 mm. thick; at the parietal eminence 7 mm.; other parts of the parietal vary from 3·5 to 5 mm. The frontal bone, in front of the bregma, is 9 mm. thick; in other parts the thickness varies from 3 to 5 mm. Thus as regards thickness of bone M.R. (1) may be described as of medium amount and in no respect different from that seen in many modern African races.

Skull M.R. (2) 30 *feet.* (Figs. 6, 7.)

Skull of a child about two and a half years of age. The milk dentition was complete, but the occipital elements of the occipital bone were still unjoined. It comes from the same level as the last, to which it has so many and striking resemblances that one infers they were members of the same family. The child shows the same degree of trigonocephaly as the adult. The skull is imperfect, the base and much of the left side—of both cranial and facial parts—are absent. The facial bones suggest the female sex. A profile drawing of the skull is seen in fig. 6, an occipital view in fig. 7.

The length of this skull, measured from glabella to occiput, is 163 mm., the greatest width—high up on the parietals—124 mm., the width being 76 per cent. of the length. It will be observed (fig. 6) that the frontal bone shows the greater upper procumbent development characteristic of childhood in all races, but particularly in that of South Africa. The length

of the skull taken between the upper part of the frontal and occipital is 167 mm., 4 mm. more than the glabello-occipital length. When the skull is placed on the Frankfort plane the frontal boss projects 12 mm. in front of the nasion. The conformation of the frontal bone suggests a sharp

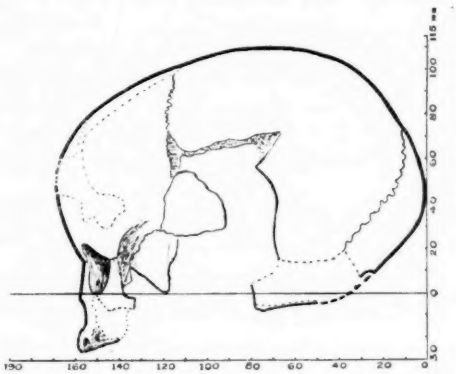


FIG. 6.

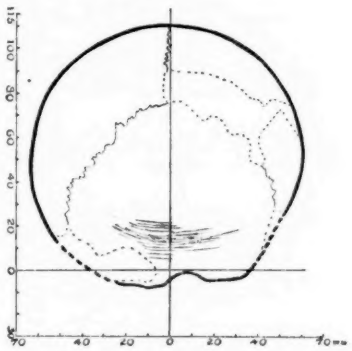


FIG. 7.

bending of the cranio-basal axis, which occurs in very many Bushman skulls. This sharp bending is an " infantile " or " foetal " character.

The occipital view (fig. 7) shows that the skull is almost circular in transverse vertical section, the parietal eminences being marked to only a moderate degree. Under the parietal eminence is a depression corresponding in situation to the hinder part of the fissure of Sylvius.

The vault of the skull is high, rising 110 mm. above the Frankfort

plane. It will be observed (fig. 6) that, as seen in profile, the parietal bone continues to ascend above the plane a long way behind the bregma.

While the brain-containing part of the skull is large, the basal and facial parts are small. The length of the face from nasion to alveolar border is 41 mm. ; of this measurement the nasal height makes up 27 mm. ; the nasal aperture is estimated to have been 13 mm. wide. Left orbit gave the following dimensions : width 29 mm., height 23 mm.

The frontal bone shows the same trigonocephalic features as the adult (M.R. (1)). The greatest frontal width was 94 mm., 30 mm. less than the greatest parietal width ; the minimal frontal width 84 mm. So little are the supra-orbital processes developed that the supra-orbital width is the same as the minimal frontal width—84 mm. The lateral halves of the frontal seem appressed ; the median keel is prominent, while the frontal bosses are absent. The manner in which the transverse ridging or curvature is recorded for the frontal bone has already been described (see fig. 5). In this child the degree of curvature was indicated by a subtense of 16 mm. taken 70 mm. in front of the bregma, and of 15 mm. taken 35 mm. in front of the bregma. The corresponding measurements in the adult were 20 mm. and 17 mm. As the trigonocephalic features are quite as emphatically marked in the child as in the adult, I infer that the transverse curvature of the frontal bone increases with age.

The exact degree of the sagittal curvature of the frontal bone is represented by the following measurements. The arc from nasion to bregma measures 124 mm. ; the direct distance from nasion to bregma 100 mm. ; the height of the frontal arc above this base line 30 mm. This highest point lay 45 mm. from the nasion, the distance being taken along the base line or chord. In the adult skull (M.R. (1)) the frontal curvature had become undone in the course of growth, but, as in that skull the glabellar region was missing, no exact comparison between the two skulls can be made.

The parietal arc in the child measured 110 mm. ; parietal base (bregma-lambda) 99 mm. ; the height of the arc 22 mm., the highest point lying 50 mm. behind the bregma.

Of the arc of the occipital bone, 100 mm. were preserved ; the inial impression was situated 55 mm. distant from the lambda.

On each side of the lambdoid suture—on the hinder parietal as well as on the upper occipital regions—the outer aspect of the bone is raised and porous, showing a disturbance in the process of ossification. The great wing of the sphenoid is also thick (6·5 mm.) and porous ; the parietal bone is 4 mm. thick, abnormal in so young a child. It is now recognised that this state of osteoporosis is due to a dietary deficient in certain (vitamin) elements. The occurrence of this condition in the child's skull throws

light on certain aberrant features of the original Boskop skull. That skull is remarkable for its massive bun-shaped thickening of the parietal bones, in the region of the parietal eminences. I have seen two other South African (native) skulls of modern date which show thickenings similar to the Boskop skull and which I regard as of a pathological nature.

Skull M.R. (3) 20 *feet.* (Figs. 8, 9, 10.)

The two skulls just described came from the deepest burials of the Matjes River Shelter; they are of particular interest—not only because of their antiquity, but because of their family resemblances. The child's skull now to be described comes from a higher level—the 20-foot level—but the manner of burial and cultural objects at this level were still of the Mossel Bay type. There had been no cultural break. The skull of M.R. (3) is shown in profile (fig. 8), occipital view (fig. 9) and full face (fig. 10). From these drawings it will be seen that only parts of the face were found; the base of the skull had disappeared, but fortunately the temporal bones have been preserved, and we are therefore in a position to ascertain the cranial characters with some degree of accuracy. The child is rather older than the last; the milk teeth are all in use, while the crown of the first permanent molar was formed but remained embedded within the jaw. The child was probably about three and a half or four years of age. The characters are in favour of the masculine sex. The bones of the skull are black in colour. There is a median frontal ridge and, although the two halves of the frontal are appressed, yet not to the degree seen in the two former specimens. The frontal bosses are moderately developed.

In this child the upper frontal projects 5 mm. in front of the nasion, against 12 mm. in the younger child just described. The glabello-occipital length is 162 mm. (upper fronto-occipital 169 mm.); the maximum width, high up on the parietal bones (fig. 9), is 129 mm., the latter being 79 per cent. of the former—on the verge of brachycephaly—and yet in every feature a dolichocephalic skull. The vault rises 109 mm. above the Frankfort plane, the highest point lying far behind the bregma. The ear is situated well forward, 85 mm. of the length being behind the ear, against 77 mm. in front of it. The inion is situated 75 mm. behind the ear, giving an occipital projection of 10 mm. The cranial base, as is usual in childhood, is narrow—the width at the bases of the mastoid processes being 102 mm., 28 mm. less than the upper parietal width. The mastoids, small elevations, descend 15 mm. below the Frankfort plane.

The frontal bones give the following dimensions: maximal width 100 mm., being 29 mm. less than the parietal width. The minimal width 86 mm.; supra-orbital width 90 mm.—the external angular processes

exceeding in development those of the younger skull. The heights of the transverse arches of the frontal bone—measured as already described

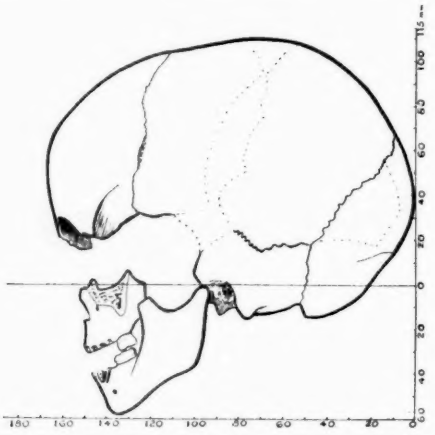


FIG. 8.

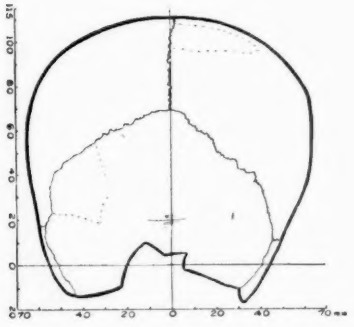


FIG. 9.

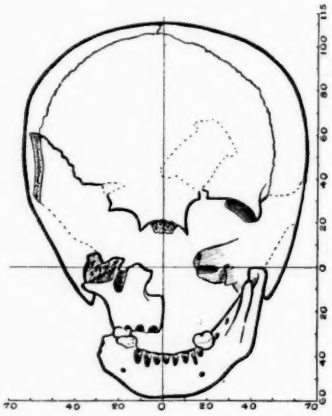


FIG. 10.

(p. 154)—are at upper point 15 mm., at lower point 15 mm., these figures being almost identical with those of the younger child. The frontal sagittal arc 118 mm. ; chord of arc 97·5 mm. ; height of arc 27 mm., against 30 mm. in the younger child. The sagittal arc of the parietal bone measures 118 mm., its chord 104 mm. ; the height of the arc 24 mm., the highest

point lying 50 mm. behind the bregma. The lower part of the occipital bone is absent, the upper tabular part measures 72 mm., the inion being situated 60 mm. below the lambda. The cerebellar region of the base is full and convex—in contrast with a flattening of the corresponding region of M.R. (1)—but this flattening is certainly the result of a remodelling of the base of the skull which takes place at puberty.

In child M.R. (3) the lower jaw already shows traits characteristic of the South African stock (fig. 8). The minimal width of the ascending ramus is 30 mm., against 24 mm. in a European child a year older. The minimal height 30 mm., against 40 mm. in the European child ; condylar height (measured from lower border—below the middle of the masseteric impression) 43 mm. ; coronoid 41 mm. (?). Behind the second milk molar the body of the mandible had a depth of 18 mm., a thickness of 13 mm.; at the symphysis the height was 23·5 mm., its thickness 11·5 mm. The chin is developing into the usual triangular elevation.

Few measurements of the face can be made. The internal angular (interorbital) width of the frontal was 23 mm. ; the width of the left orbit 27 mm. As in child M.R. (2) there was an oblique depression under each parietal eminence. The suture between parietal and temporal bones was of the low Bushman form ; the bevelling on the squamous margin of the parietal bone was 6 mm. in depth.

Only molar teeth of the milk dentition were preserved—the first and second molars of the lower jaw and the second of the upper. The first lower measured 8 mm. (medio-distal) and 6·5 mm. in its transverse (labio-lingual) diameter. The two anterior cusps were slightly separated and of almost equal height. The second molar was 10·0 mm. long by 9·5 mm. wide. The corresponding diameters of the upper milk molar were 8·5 mm. × 8·2 mm. On the lingual aspect of the crown of the second upper milk molar, and on the labial aspect of the corresponding lower molar, were two minute pockets in the enamel, corresponding to the site at which cusps of Carabelli are developed. There is no trace of these pockets in the permanent teeth.

One point relating to the ear of this child I have omitted. In the South African stock, not only did the mastoid tend to be small, but the tympanic plate, which forms the floor of the ear-passage, is often greatly reduced in size, not infrequently retaining the foramen which separates the anterior from its posterior processes. In this skull, M.R. (3), the foramen has been filled up in the normal way, but the anterior part measures only 5 mm. from its inner to its outer margin, while the posterior part, which goes to form the projecting free margin of the vaginal plate, is only 11 mm. from its inner margin to the outer rough border situated on the floor and posterior wall of the meatus. The tympanic plate, as in the

Boskop skull, tends towards a horizontal position. With this is associated a shallow glenoid depression for the condyle of the mandible.

Mandible M.R. 21 feet. (Figs. 11, 12, 13.)

From approximately the same level as the skull of the child just described came the left half of the mandible represented in fig. 11. Unfortunately the alveolar part in front of pm^2 is lacking. The ascending ramus is of a peculiar shape—very different from the ramus of the usual South African type—well represented by another mandible (fig. 12) from a rather higher (15 feet) level. The mandible represented in fig. 11 has a rounded open angle, whereas the type is almost right-angled with everted borders. In M.R. 21 feet the minimal width is 32 mm., minimal height 44 mm., condylar 59 mm., coronoid 58 mm.; the corresponding figures

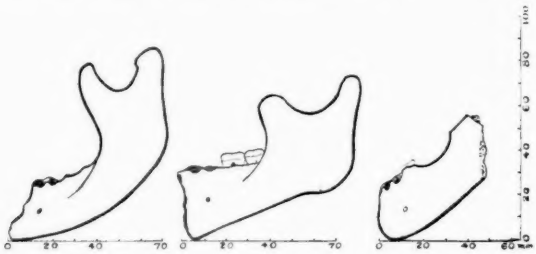


Fig. 11. Fig. 12. Fig. 13.

for mandible M.R. 15 feet (fig. 12) are 41 mm., 41 mm., 63 mm., 50 mm. And yet, if we take the diameters of the body of the mandible at the site of m^2, both are almost the same—the depth in M.R. 21 feet being 24 mm., its thickness 17 mm.; in M.R. 15 feet the measurements are 24 mm., 19 mm. The peculiar features of mandible M.R. 21 feet I do not attribute to a difference of race, but to an aberration of growth which is very common in the more highly civilised races—betokening an elongation of the face, which thus assumes an oval Madonna outline. The features of this mandible are feminine, whereas the example beside it (fig. 12) is masculine. When this female mandible is placed on a metric board the condyles rise 70 mm. above the horizontal plane, whereas in the male their height is 55 mm. But, whereas the chin of the male projects 104 mm. in front of the vertical condylar plane, the projection in the woman's jaw is only 95 mm. The lower part of the chin is present; it is modelled in the usual South African way. All the teeth have dropped from their sockets in the woman's mandible, but from them one infers that the total molar length was only 30 mm. In the mandible represented in fig. 12, the symphysis

was 31 mm. deep and 18 mm. thick. The chin formed the usual triangular elevation, its tip projecting 9 mm. in front of the alveolus for the median incisors.

From the 20-foot level came the facial parts of a man's skull. They are drawn in figs. 26, 27, and are described on pp. 175–177. This specimen is of great value for the light thrown on the facial features and racial traits of the earlier Matjes River people.

Skull M.R. (4) 12 *feet.* (Figs. 14, 15, 16, 17.)

We now come to what may be regarded as the most important specimen from the Matjes River Shelter. It was unearthed from the 12-foot level, but the culture and mode of burial at this horizon are the same as at the lower levels. M.R. (4) is a man's skull. The coronal suture is still open ; the sagittal and lambdoid are in process of fusion, but still clearly traceable. Its importance lies—as Professor Dreyer has already stated in his original communication—in its close resemblance to the original Boskop skull. Here, however, more of the skull is preserved and the bones are in their original relations to each other. The skull is black in colour, but of a dense texture giving the resonance of porcelain. It is much less mineralised than the Boskop skull, but this may be due to a difference in the matrices in which the skulls had been preserved. A glance at fig. 16 showing its occipital aspect (drawn with the skull in the Frankfort plane) reveals the swelling of the parietal eminences, the great width of the skull in its upper parietal region, its narrowing as it descends to the base—all infantile (pedomorphic) features.

The same features are seen on the upper aspect (fig. 15) ; great width at the parietal eminences, with relative narrowness in the frontal region. Then the vault is high and its sagittal outline shaped much as in the Boskop skull ; the height of the vault above the Frankfort plane is 124 mm. ; this height in the Boskop skull I estimate as 115 mm. In the Boskop skull the parietal eminences have a thickness of 11 mm., here they are 7 mm. ; the rest of the tabular bones vary in thickness from 3 to 6 mm. The glabello-occipital length of the Boskop skull I estimate at 205 mm. ; here it is 203 mm. The greatest width of the Boskop skull is 154 mm. ; here it is 149 mm. In the Boskop skull the width is 75 per cent. of the length ; here it is 73·4 per cent. The capacity of the Boskop skull I estimate to have been about 1700 c.c., but other estimates place it above 1800 c.c. The base of M.R. (4) is missing ; its capacity has to be estimated by formula which gives a capacity of about 1660 c.c., against 1480 c.c. for the average Englishman and 1380 c.c. for the average Bushman.

On looking round for modern representatives of this M.R. (4), or Boskop

type, amongst the collections of skulls in the Museum of the Royal College of Surgeons of England, I found Bushman and Hottentot skulls which were brought to England some eighty years ago when pure Hottentots were still plentiful. These early Hottentot skulls have all the characteristics I was in search of except size; M.R. (4) represents simply a large-headed Hottentot. In both are the same Boskopoid features of forehead—the deep transverse constriction between external angular processes and frontal boss and the same horizontal modelling of the supra-orbital ridge.

I turn now to the frontal characters of M.R. (4). The maximum frontal width 126 mm., 23 mm. less than the maximal parietal width; the minimal frontal width 102 mm.; the supra-orbital width—only a little more—106 mm. The corresponding measurements of the Boskop skull are: frontal maximum 126 mm., minimum 102 mm., supra-orbital width 114 mm.; only in the latter measurement do we see a more primitive mark in the Boskop skull, the other frontal measurements are the same. In both the frontal bosses are well marked, but more emphatically in the Boskop than in M.R. (4).

In M.R. (4) the frontal arc measures 145 mm. against 150 mm. in the Boskop skull. The parietal arc is 130 mm. against 139 mm. in the Boskop. Only 112 mm. of the occipital arc is preserved in M.R. (4), 70 mm. of which lie above the inion. The original length of arc was probably about 120 mm. No doubt the Boskop skull has the longer sagittal cranial arc. Traced across the skull from porion to porion the arc of M.R. (4) was 180 mm. on the right side and 175 mm. on the left.

The upper part of the frontal of M.R. (4) had been very full in youth and, although still retaining an upper prominence, the upper forehead lies 7 mm. behind the glabella and 3 mm. behind the nasion when the skull is placed in the Frankfort plane. The direct distance from nasion to bregma in M.R. (4) is 122 mm., the highest point of the frontal arc—which lies 60 mm. distant from the nasion—is 30 mm. above the frontal chord, the same as in the child's skull M.R. (2). The chord of the parietal arc measures 116 mm., the highest point—lying 65 mm. behind the bregma—rising 27 mm. above the basal chord. The height of the transverse arc of the frontal (estimated as on p. 154) is 13·5 mm. at the upper point and 9·5 mm. at the lower. The corresponding measurements for the Boskop skull are 8·5 mm. and 7 mm. Skull M.R. (4) had a frontal bone which was more curved in its transverse arch than Boskop, but much less than in the three Matjes River skulls already described. I do not look upon M.R. (4) as being of a different race from the other three; he is, I think, a less aberrant—to a lesser degree trigonocephalic—than the other three. All are essentially South African or Boskopoid.

Fortunately in M.R. (4) the left malar bone is preserved, for the South African stock had and has certain peculiarities of the cheek. The malar

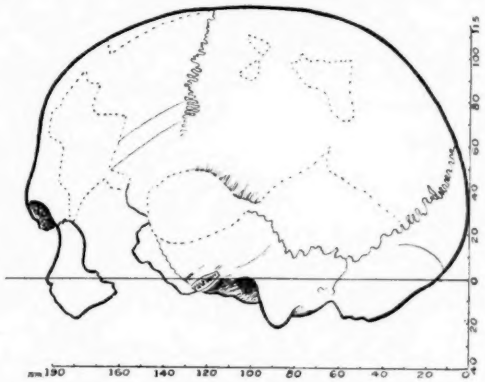


FIG. 14.

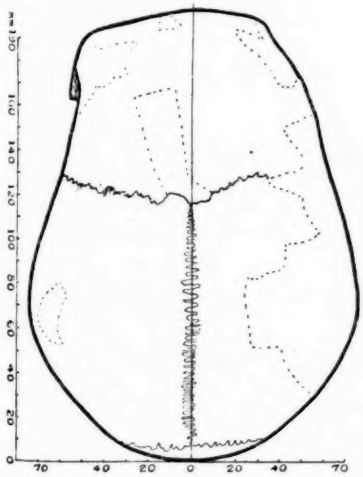


FIG. 15.

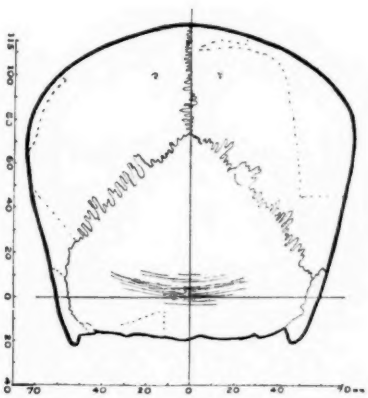


FIG. 16.

occupies an advanced position, as in Mongolian skulls. In M.R. (4) the orbital margin of the malar lies 87 mm. in front of the mid-meatal vertical plane, the nasion 99 mm. The difference between these measurements, 12 mm., is an indication of the flattening of the upper or orbito-nasal region of the face. The zygomatic arch is not laterally prominent; the

bizygomatic width was only about 124 mm. It is the forward and also lateral prominence of the cheek-bones and the peculiar development of the orbital part of the malar bone which gives the cheeks of Bushmen their characteristic appearance. Often the orbital margin of the malar—in its lower part—forms a flat ledge or shelf; this is seen in the malar of M.R. (4) (fig. 17, *s*). The orbital shelf of the malar occurs in other racial stocks, but in none does it happen so frequently or has so pronounced a development as in the South African stock. As will be seen from fig. 17, the outer supra-orbital nerves pursue a deep course—also a feature of the South African stock.

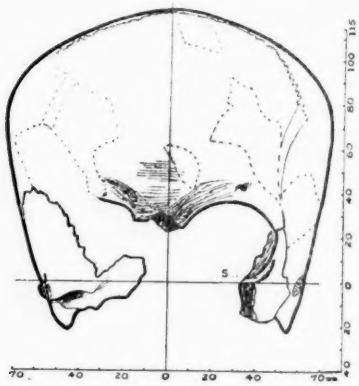


FIG. 17.

The ear-passages are situated rather in front of the mid-point of the skull (fig. 14), the post-auricular segment measuring 103 mm., the pre-auricular 100 mm. The mastoids are relatively small, descending 22 mm. below the Frankfort plane; the bimastoid width of the base is only 116 mm. The inion lies 91 mm. behind the ear; the occipital point 103 mm.; the occipital projection is thus 12 mm. The tympanic plate unfortunately has been broken away, but the thin edges of attachment show that it was under-developed.

The interorbital region of the frontal was flat, about 26 mm. wide; the impressions for the nasal bones indicate that their combined width was about 10 mm. At the glabella the frontal bone was 17 mm. thick.

M.R. (4) was therefore a man with a big head and a large brain, showing the characteristic features of the Boskop type of South Africa. In the characters of forehead, cheek-bone and mastoid processes he had the features characteristic of the South African stock. Many of his features are best explained on the supposition that in the South African stock there was a strong tendency to retain infantile or juvenile features—pedomorphic characters, as Professor Drennan has named them.

Skull M.R. (5) 10 *feet.* (Figs. 18, 19, 20, 21.)

This skull, that of a man, comes from a higher level than the last, but the manner of burial and cultural surroundings were the same. The colour of the bones, in this case, are of a light brown, and there is a tendency for the bones to crumble, which is not the case in the black skull M.R. (4).

In this case the sutures are quite closed, the coronal and sagittal being almost obliterated; the lower part of the lambdoid is clearly traceable.

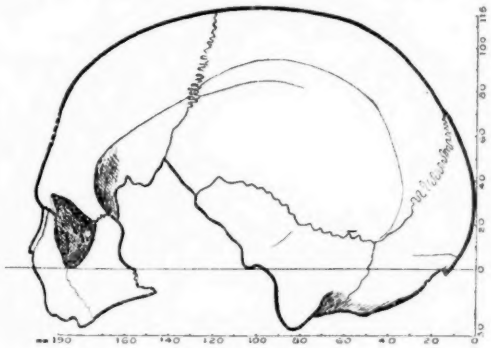


FIG. 18.

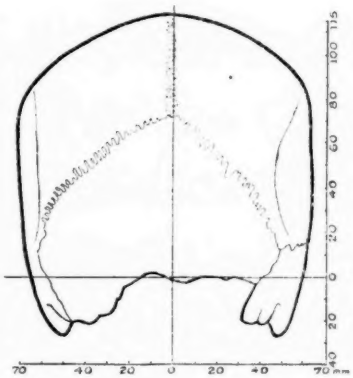


FIG. 19.

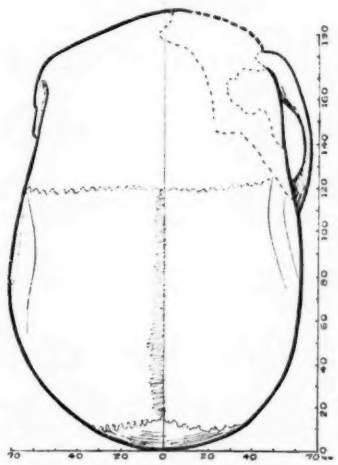


FIG. 20.

The man was over fifty years of age. The base of the skull and the greater part of the face is missing. The bones of the vault are thick: 9 mm. at the parietal eminence, 10 mm. at upper frontal, 14 mm. at inion; in other parts 5–7 mm.

As to the man's racial nature there can be no doubt: he has the characteristic features of malar, with pronounced orbital shelf, the typical

external process of supra-orbital, save that it is less strongly developed than in the skulls of the men just described, and the frontal constriction or groove not so deeply developed. The mastoid processes are strongly developed, descending 27 mm. below the Frankfort plane. The parietal eminences fade into the general contour. The peculiar features of the Boskop man are being replaced by those which are more commonly seen in the skulls of Strandloopers. It may be that this skull betokens the arrival of another local breed of the South African stock at the Matjes River Shelter, or it may be that this man represents only a normal variant of the local race we have been dealing with so far.

M.R. (5) is a skull of large dimensions, the glabello-occipital length being 201 mm.; 101 mm. being behind the ear point, 100 mm. in front. The inion, merely an impression, lies 91 mm. behind the ear, the occipital projection being 10 mm. The occipital view (fig. 19) shows the lateral walls almost vertical—the upper parietal width being 135 mm., the lower 132 mm.; the mastoid width 120 mm. The width is 67·1 per cent. of the length, being thus a narrow, long skull. The vault rises 118 mm. above the Frankfort plane. From these dimensions one estimates that the cranial capacity was in the neighbourhood of 1490 c.c.—that falling easily within the large-brained series, counting 1450 c.c. as the lower limit of this series.

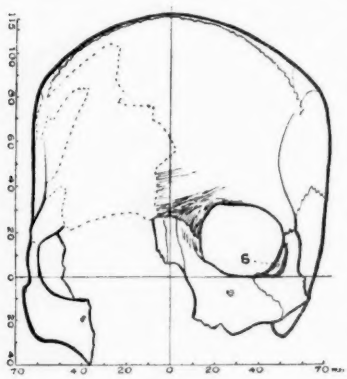


FIG. 21.

Turning to the characters of forehead we find: maximal width of frontal 120 mm., 15 mm. less than maximal parietal; minimum frontal 96 mm., supra-orbital width 112 mm.—16 mm. more than the minimal width—showing a strong primitive development of external supra-orbital processes. The frontal bosses are weakly developed; the upper part of the forehead falls 8 mm. behind the nasion and 11 mm. behind the glabella—a more receding forehead than in any of the specimens described so far.

The frontal arc measures 136 mm., its chord 120 mm.; the height of the frontal arc above the chord 27 mm. The parietal arc 120 mm., its chord 112 mm.; height of arc 21 mm., the highest point being 68 mm. distant from the bregma. Of the occipital arc 72 mm. are preserved; the inion lies 57 mm. below the lambda. The original length of the occipital arc was approximately 120 mm., while in M.R. (4) the transverse arc of the skull, from porion to porion, was 175 mm. on left side and

180 mm. on right, the corresponding measurement in M.R. (5) was 165 mm. on each side. The temporal ridges ascended higher on the sides of the skull in M.R. (5) than in M.R. (4). In M.R. (5) the malar bone is strongly developed, with a forward prominence and a well-marked orbital shelf. Nevertheless, as may be seen by comparing figs. 16 and 18, the naso-orbital region of the face was less flat in M.R. (5) than in M.R. (4). In the latter the orbital margin was 87 mm. in front of the vertical meatal plane ; here it is only 75 mm. ; in M.R. (4) the nasion was 99 mm. in advance of the same plane ; here it is 96 mm. In M.R. (4) the nasion is only 12 mm. in advance of the orbital margin ; in M.R. (5) it is 21 mm. in advance. In M.R. (5) the nasal bones were slightly arched transversely ; 10 mm. is their combined width ; the height of the transverse arch of the nasal bones was 2·5 mm. The width of the interorbital process of the frontal 27 mm. ; width of left orbit 39 mm. ; height 30 mm. ; bizygomatic width 130 mm. (?) ; maxillary width between lower ends of malo-maxillary sutures 100 mm., showing lateral prominence of cheeks.

The features of this skull verge towards Professor Drennan's Australoid type of South Africa, and yet in its essential racial features, as seen in forehead, nose and cheek-bones, I think we have sure evidence we are dealing with a variety of the prehistoric South African stock.

Skull M.R. (L). (Figs. 22, 23.)

This calvaria comes from a still higher level of the shelter—from Professor Dreyer's Mytilus layer, above the Mossel Bay culture and within the zone of microlithic (Wiltonian) industry. It has female characters, and, as the sutures are still open, we may presume the owner to have been under thirty at the time of death, probably well under that age. The bone is dark brown in colour and in state of preservation does not differ materially from M.R. (5). The base and the greater part of the left side of the skull are missing ; so are all parts of the face. Although all the bones which yield the most characteristic racial traits are missing, the calvaria has the conformation met with in the South African stock. M.R. (L) might well be the female counterpart of M.R. (5). The vault is of moderate thickness ; central parietal 5 mm. ; lateral lower parietal 3 mm. ; upper median occipital 8 mm. ; occipital, over the inion, 14 mm.

The glabello-occipital length is 178 mm. ; the width, calculated from the right half, 118 mm., the width being 66·6 per cent. of the length—a short skull, and very narrow. The vault, however, is high—its highest point rising 116 mm. above the Frankfort plane. Such dimensions indicate a cranial capacity of about 1230 c.c., which is rather below the mean (1260 c.c.) found by Dr. Shrubsall in modern Bushwomen.

The forehead has the usual upper prominence, being bent forwards so that the upper forehead is 7 mm. in advance of the nasion. The frontal arc is 130 mm., its chord 112 mm. ; the height of the arc above the basal chord 32 mm.—a much-arched bone, more than in any example so far examined from the Matjes River site. As in the skulls from the deepest level of the site, there is a median frontal keel and poor development of the

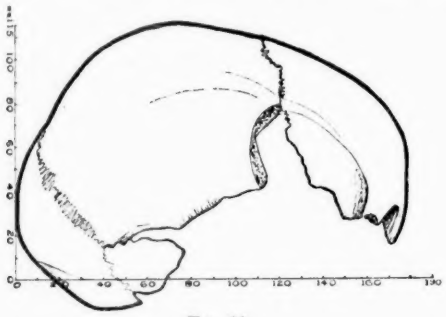


FIG. 22.

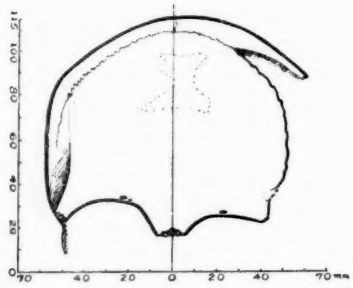


FIG. 23.

frontal bosses. Like the skulls from the deeper levels, the frontal is sharply curved in its transverse arch—the height of the upper arch being 15 mm. and the lower 15 mm.—almost identical in amounts to those of the deeper and older skulls. The frontal widths have to be calculated from the right half. The maximum width is 105 mm., only 13 mm. less than the maximal parietal. The minimal frontal width 94 mm. ; the supra-orbital width 180 mm.—14 mm. more than the minimal width, a remarkable predominance in a female skull. The supra-orbital width is also greater than the maximal frontal width, another primitive mark. In its size and shape the external angular process is similar to that of the male skull M.R. (5).

Both are narrow skulls, although one has a large capacity and the other a small. The parietal arc measures 125 mm., its chord 110 mm. ; and the height of the arch is 26 mm. The occiput is full and rounded ; it projects 10 mm. behind the inion ; the cerebellar receptacula are full and round. In all its calvarial features we see in this skull the retention of infantile characters. The parietal eminences are moderately developed. The supra-orbital nerves emerge by marginal foramina ; the interorbital process of the frontal is narrow, being only 14 mm. wide.

Skull M.R. (O). (Figs. 24, 25.)

A child's skull ; the milk dentiton is complete, the teeth are but little worn ; the alveolar cavity for the first permanent molar is partly preserved. The child's age was probably two and a half years. It comes from the upper Mytilus stratum—the same as the last. It reproduces exactly the juvenile form of the Boskopoid woman from Zitzikama, described by Professor Dart. The distance from Zitzikama Rock Shelter to that of Matjes River is only a score of miles or so. M.R. (O), in my opinion, reproduces in a typical form the big-brained Boskopoid type, and I do not think it can be regarded as indicating more than a variant of the other skulls from the Matjes River site. The glabello-occipital length is 172 mm., but the greatest length—from the upper projection of the forehead to occiput—is 180 mm. The forward bending of the frontal, the low extended contour of the suture between parietal and temporal (fig. 24), indicate a great degree of bending in the basi-cranial axis, a common feature in the South African stock. Extreme bending of the cranial base is a developmental stage which tends to pass unchanged into adult form in the South African stock.

When the occipital view is examined, we note the greatest width is high up on the parietal, the eminences of that bone being emphatically marked. The upper parietal width (calculated from the left half) is 120 mm. ; at the lower parietal the width is only 109 mm., while at the bases of the mastoid the width shrinks to 92 mm., exhibiting all the features which characterise an infantile stage of growth. The mastoids form low bony projections descending 14 mm. below the Frankfort plane. The cerebellar receptacula are full and descend 26 mm. below that plane.

The width, 120 mm., forms 69·7 per cent. of the glabello-occipital length (172 mm.)—a long-headed but not narrow-headed child. The vault rises 102 mm. above the Frankfort plane, the highest point being far back—50 mm. behind the bregma. In its rather low, long, level roof (as seen in profile, fig. 24) this skull reproduces features of the original Boskop skull. Only in this case we have no reason to expect that the cranial

capacity will be high ; in the third year we expect the capacity to have reached 80 per cent. of the total. I estimate that the capacity in M.R. (O)

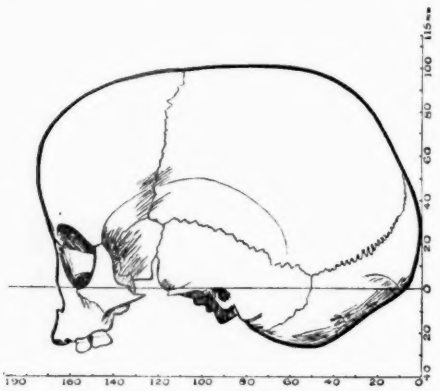


FIG. 24

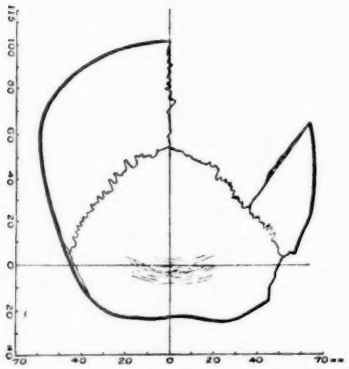


FIG. 25.

was about 1050 c.c. ; the adult capacity would likely be in the neighbourhood of 1300 c.c. Not unlikely M.R. (O) is a girl's skull.

In this case the bending of the frontal bone is extreme. Its sagittal arc is 125 mm. ; its chord 100 mm. ; the height of arch 34 mm. The parietal arc is long, 121 mm. ; its chord 107 mm. ; the highest point of its arch—65 mm. distant from the bregma along the base line—is 26 mm. ; the occipital arc measures 112 mm., 56 mm. lying above the inial impression.

The occipital chord measures 89 mm. The height of the occipital arch is 28 mm.

The frontal widths are : maximal 94 mm., 24 mm. less than the maximal parietal ; the minimal width 86 mm. ; supra-orbital width 86 mm. The upper forehead projects 9 mm. in front of the nasion. The forehead above is wide, the frontal bosses being well developed as in the Boskop skull. The supra-orbital nerves pursue a deep course.

The ear is situated in front of the mid-point of the glabello-occipital length, 92 mm. being post-auricular, 80 mm. pre-auricular. The tympanic plate has the characteristic horizontal position ; its two processes have met on the floor of the meatus and enclosed a foramen. The glenoid cavity is shallow, the articular eminence undeveloped. The occiput is low and rounded, projecting 10 mm. behind the inion. The vault has a thickness of 3 mm.

The face, compared to cranial dimensions, is small. The naso-alveolar length is 41 mm. ; the nasal height 31 mm. ; nasal width 19 mm. The nasal bones are small and flat. The left orbit measures : height 28·5 mm. ; width 29 mm. The bizygomatic width I estimate to have been 84 mm.

The left half of the palate is preserved, with two teeth, the first and second milk molars. The socket for the milk canine shows that the root of that tooth was deeply grooved in its labial aspect. The first milk molar has three cusps, two outer and one inner ; its length (medio-distal diameter) of crown 6·7 mm. ; its width 8 mm. The dimensions of the crown of the 2nd milk molar are : length 9·5 mm. ; width 9·2 mm. There are the usual four cusps. On the lingual aspect of the antero-internal cusp of the second milk molar is a pocket in the enamel of the same nature as those seen in the milk teeth of the child from the deepest level.

When all the features of this skull are taken into account I cannot think its presence indicates the arrival of a new race at Matjes River ; at most, the people who practised the Wilton culture at this site were but a local variant of the same South African prehistoric stock which has occupied the site at a much earlier period.

Upper and Lower Jaws M.R. (*X*). (Figs. 26, 27.)

The parts are particularly valuable as they come from the deepest level and thus help to throw light on the facial characters of the earliest inhabitants of the M.R. site. The jaws, which are of a black colour and in a state of preservation very similar to skull M.R. from the 20-foot level, are undoubtedly of the same individual, almost certainly of a man. The teeth are so ground that more than half of the crowns is worn away, exposing a hollowed field of black dentine. The lower jaw (as seen in

profile, fig. 26) has an opener angle than is common (somewhat reminiscent of the peculiar mandible M.R. 21 feet) and the ascending ramus has not the usual square shape. Another mandible from a deep level, shown in fig. 11, is also aberrant in its shape, but more so than this one. The minimal width of the ascending ramus is 35·5 mm. ; its minimal height 43 mm. ; coronoid height 52 mm. ; condylar height 62 mm. Its body, at the 2nd molar, is 22 mm. deep and 15 mm. thick ; at the symphysis the depth is 35 mm. ; the thickness 13 mm. When placed flat on its lower border (in the method already described, p. 157) the chin projects 102 mm. in front of the vertical condylar plane, the point of the chin being only 1 mm. in front of the alveolar border. The chin has the usual triangular shape ; the digastric impressions are extensive and situated on the lower aspect of the symphyseal region of the jaw. The height of the condyles, when the

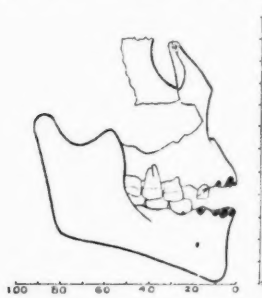


FIG. 26.

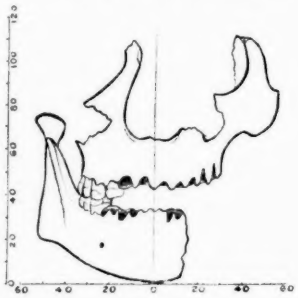


FIG. 27.

jaw rests on the board, is 53 mm. The length of the outer surface of the jaw, measured as already stated, is 105 mm. The three lower molars had a combined length of 30·2 mm. : the 1st, 10·2 mm. ; 2nd, 10·6 mm. ; 3rd, 9·8 mm. The width of crown of m^2, 9·5 mm. The mental foramen opened just anterior to the situation of the first molar. In spite of its aberrant features, the essential conformation of this mandible is that met with in various members of the South African stock.

The upper jaw, viewed from the front (fig. 27), gives us other features of the face. The malar bone shows the orbital shelf developed to a high degree. The malar margin of the orbit projected far forwards and is shaped as in the skull from the 10-foot level. The nasal opening was 26 mm. wide ; its sill shows a slight paranasal fossa and has no sharply marked margin ; the incisor alveolus slants downwards and forwards, so that the alveolar point lies 11 mm. in front of the nasal spine. The depth of the upper jaw—from nasal sill to alveolar point—is 23 mm. The length of the upper face was just over 70 mm. ; the total length of face 112 mm.—a

long face for people of the South African stock. The maxillary width, 90 mm., is a moderate amount. As will be seen from fig. 26, there is a proclivous alveolar prognathism.

For a man of a primitive race the dental palate has moderate dimensions. Its greatest width, measured between the outer borders of the second pair of molars, is 63 mm. ; at the outer borders of the sockets for the canine teeth 39 mm. ; the antero-posterior length of the dental palate, measured from the median alveolar point to the median post-molar point, 52 mm. The total length of the three upper molars 29 mm. The sockets show that the three roots of the last molar were fused ; in the second molar the two labial roots were fused ; in the first the labial roots were separate, but the lingual root joined the posterior outer root. The depth of the palate was 20 mm. All of the characters of the face, palate and teeth are such as are met with in all members of the South African stock.

Mandible M.R. (15). (Figs. 28, 29.)

The body and left ascending ramus are preserved. The bone is ashen grey in colour. It has the typical features of the South African stock. The characters are masculine ; from the 15-foot (Mossel Bay) level. Minimal width of ascending ramus 41 mm. ; minimal height 41 mm. ; coronoid height 50 mm. (?) ; condylar 63 mm. As usual the biangular

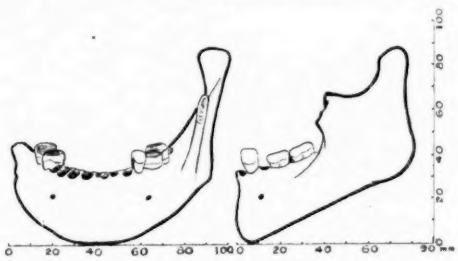


Fig. 28. Fig. 29.

width (106 mm.) is only a little less than the bicondylar (125 mm.), so straight does the ramus ascend when viewed from the front. At the 2nd molar the body is 24 mm. deep, 19 mm. thick ; at the symphysis the depth is 31 mm. ; thickness 17 mm. The chin forms the usual slight triangular elevation, 28 mm. wide at the base and 23 mm. high. When laid on its lower border the chin projects 104 mm. in front of the vertical condylar plane ; the height of the condyles 55 mm. The chin projects 9 mm. in front of the alveolar border. The length of the horizontal arch of the mandible, measured as on p. 157, is 110 mm. The muscular markings on

the posterior aspect of the symphysis are as in mandible M.R. (1). The total length of the three lower molars is 30·5 mm—the 1st, 10 mm.; 2nd, 11 mm.; 3rd, 9·5 mm.; width of crown of 2nd, 10·5 mm. The crowns are worn down so that the bases of the cusps are exposed.

Mandible M.R. (nn). (Figs. 30, 31.)

Greyish white in colour; probably from the upper Wiltonian burial. The markings are feminine; second permanent molar just erupted; second milk molar not shed; permanent incisors, canines and first premolars in use; third molar not yet erupted; probably from a girl about twelve years of age. The mandible, while showing mainly typical characters, in its open angle has resemblances to two other mandibles already described (see figs. 11, 26). Ascending ramus, minimal width 31 mm.; minimal

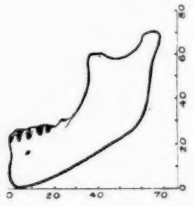


Fig. 30.

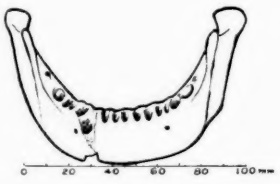


Fig. 31.

height 35 mm.; coronoid height 47 mm.; condylar 52 mm. At the 2nd molar the depth of the body is 23 mm.; thickness 15 mm.; at the symphysis the depth is 25 mm.; thickness 12 mm. On the posterior aspect of the symphysis the muscular markings for muscles are very distinct. The triangular elevation on the chin is slight, 17 mm. wide at base and 12 mm. high. When the mandible is laid on its lower border, with condyles against a vertical plane, the chin projects 93 mm. in front of the plane, 7 mm. more than the alveolar border. The condyles in this situation have a height of 43 mm. The sockets show that the first molar had its anterior and posterior roots separated; in the second molar there was a partial fusion of the roots. The bicondylar width was 113 mm.; the biangular (bigonial) 91 mm.

Mandible M.R. (an). (Figs. 32, 33.)

Although no information is given concerning the level from which this specimen came, its colour and state of preservation point to the upper Mytilus stratum. Only the body has been preserved. The characters on the whole are feminine—a woman just adult. The teeth are very

slightly worn ; the incisors have dropped from their sockets ; all the others are present. At the symphysis the depth is 33 mm., thickness 14 mm. ; at the 2nd molar, depth 23 mm. ; thickness 18 mm. There is the usual papular triangular chin. The total length of the premolar and molar crowns is 44 mm., the premolars contributing 13 mm., the molars 31 mm. The 1st molar has a crown length of 10·5 mm., width 10 mm. ; first and second molars have five cusps ; the crown of the third is somewhat reduced. The width of the dental arch between the outer surfaces of the second pair of molars is only 58 mm. ; the length of the arch (from median alveolar to median post-molar point) is 48 mm. All the teeth were in perfect health. When the first molar is extracted it is seen that the roots are short. The vertical height of the tooth from chewing surface to tip of roots is 19 mm.—9 mm. representing roots, 10 mm. represent height of body and crown. The enamelled part of the body is 7 mm. in height. Professor

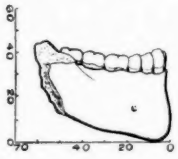


FIG. 32.

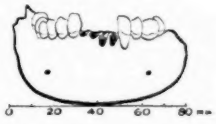


FIG. 33.

Drennan * states that the Bush people of Colesberg had short roots ; he found that in the 1st lower molar the root length varied from 9·8 mm. to 16 mm., the mean being 12·4 mm. As we shall mention presently, Mr. J. C. Middleton Shaw has observed that there is in the South African races a tendency for the body of the tooth to enlarge at the expense of the roots ; that tendency is seen in the teeth of this jaw and in those of other specimens already described.

Mandible M.R. (ann). (Fig. 13.)

Another fragment of mandible with no history but its appearance—of a black colour, although not dense—suggests an origin from the Mossel Bay level. It is merely a fragment ; the characters suggest age and femininity, but it has the essential Boskopoid features. The second premolar had been lost long before death ; the third molar had never developed—for absence from lack of development of the third molar is not uncommon in women of the South African stock. At the 2nd molar the body of the mandible was 23 mm. deep and 13 mm. thick ; at the symphysis the depth was 28 mm., the thickness 11 mm. We have here an illustration of one of the tendencies of the South African stock—a reduction of dental development. The other

* *Loc. cit.*, p. 157.

tendency is towards unusual enlargement of brain. Somehow there is a correlationship between these two developmental tendencies.

The Teeth.—In the course of descriptions just given, mention has been made of dental characters. One of these was the tendency to enlargement of the body at the expense of the roots, a tendency to which I gave the name *Taurodontism*. Mr. J. C. Middleton Shaw, in a paper published in the Journal of Anatomy (1928, vol. lxii, p. 477), has called attention to the occurrence of taurodontism in the molar teeth of prehistoric South African races. The manner in which taurodontism is manifest in South African races differs materially from that seen in races of Neanderthal man. In the latter the molar teeth become cylindrical from crown to root, the bodies extending down until only the roots-tips are discernible at the bottom of the cylinder. In South African races the body enlarges at the expense of the roots, but the roots tend to come together—to fuse—so as to form a conical base in which all three roots are still plainly visible.

The separate teeth, from the deeper levels of Matjes River Shelter, differ in no respect from the teeth of the Colesberg Bushmen described by Professor Drennan. An upper median incisor has a total length of 23·5 mm., of which the crown makes up 6 mm. The crown is 7 mm. wide and 7 mm. in labio-lingual thickness. A right 2nd lower molar is the largest found in the shelter, yet its length of crown is only 11 mm. and its width 10·5 mm. The total length of this tooth is 18 mm., the roots making up 7 mm. of the length ; the crown 3 mm. ; the body 8 mm. Here the degree of taurodontism is considerable ; it is a Boskopoid feature. In a 2nd upper molar the crown was 9·6 mm. long and 12 mm. wide ; the total length of tooth was 18 mm., of which the roots made up 8 mm., the crown 4 mm. and the body 6 mm. Here again was a considerable degree of taurodontism.

Summary.

Let me indicate as briefly as I may why I consider the discovery of the prehistoric Rock Shelter at Matjes River, and its excavation of its deposits by Professor Dreyer and his colleagues, as events of the highest importance to those who are inquiring into the history of human races. Our knowledge that South Africa, in remote times, had been inhabited by a peculiar big-brained race began with the discovery of Boskop man in 1913. That discovery we owe, in the first place, to Mr. F. W. FitzSimons of Port Elizabeth Museum. Then came the exploration of the rock-shelters of Zitzikama by Mr. FitzSimons and the recognition by Professor Dart that amongst the older remains found there were people with heads shaped as in Boskop man and with equally great cranial capacities. Then came the discoveries in the Zuurberg site, also owing to Mr. FitzSimons, and the

description of the human remains by Mr. L. H. Wells of the Witwatersrand University (South African Journal of Science, 1929, vol. xxvi, p. 806). The remains found at that site are comparable to those found in the upper strata at Matjes River Shelter; the two sites are not far apart. There is no doubt that the human types from the Zuurberg site are of the same kinds as Professor Dreyer has found in the Matjes River Shelter. Mr. Wells has separated the prehistoric Zuurberg people into several types—Springbok flats type, Boskopoid Bushmen type and Australoid Bushmen type. He seeks to explain the mixture of cranial characters by presuming a mixture of races. I see in his types merely the natural local variants of a single type—that of the prehistoric South African stock.

Then came the discovery by the Messrs. Peers of a " Still Bay " deposit in Skildergat Cave and in an undisturbed deposit the finding of a fossil skeleton of a large-headed man of the true Bushman type. This type I regard as a local development of the prehistoric South African stock. We do not find the true Bushmen type in Matjes River Rock Shelter,* but yet in facial and mandibular development and in certain features of the skull there are so many close resemblances that we cannot doubt that Skildergat man and Matjes River man represent local developments of the same stock.

At the same time as the Skildergat man came to light Professor Drennan discovered and pieced together the Cape Flats man—one showing a good-sized head, but long and narrow and with frontal characters other than are usually associated with the South African prehistoric Boskop or Bush types. Yet I am not certain that the Cape Flats man should be excluded from this stock, especially when account is taken of features similar to his amongst the Zuurberg people and also amongst the Matjes River people.

These discoveries opened up a picture of South Africa as the home in prehistoric times of one of the most peculiar types of ancient humanity known to us—one tending to produce individuals with extremely large brains, with characteristic modelling of eyebrow ridges, cheek-bones and lower jaws, and with a tendency to retain in adult years characters which are usually transient in the development or growth of other stocks of humanity. Professor Drennan has employed a most useful word to indicate this tendency—Pedomorphism. I look on the flexure of the base of the skull with the consequent flattening of the suture between the temporal and parietal bones—the contour of the sagittal arc of the parietal, the forward position of the upper frontal as pedomorphic characters. To the same group I include a tendency to dwarfism and to retain the less pigmented skin of foetal life and to hairlessness of body. We have no knowledge of the South African race in other parts of the world—certainly not in Europe nor in North Africa.

* The Bushmen type was not sent to Sir Arthur Keith.—T. F. D.

Mr. H. S. Gear has described the skeleton of a prehistoric man of a Boskopoid type from Kalomo in Northern Rhodesia. Dr. Hugh Stannus found in an old beach at the north end of Lake Nyassa the skull of an unmistakable Bushwoman. It is much more likely that these are strays from South Africa than indications of a southward migration of the stock. On the evidence as it stands we are justified in supposing that South Africa is the evolutionary home of the pedomorphic stock, and that in the course of time it has become differentiated into a large number of more or less distinctly marked local races. Further, we must look on lighter-skinned and the black-skinned (negro) stocks of Africa as the products of a common ancestry.

The importance of the discoveries made at the Matjes River site lies in the light thrown on the problems relating to the origin of the South African stock. For the first time a series of human remains have been found with the Mossel Bay culture. That culture I presume to be contemporary with, or just subsequent to, the "Still Bay" culture. The Still Bay culture deposits in the Cape Peninsula yielded to Messrs. Peers a true Bushman—taller, stronger and bigger-headed than are the modern representatives of that race—which however, as Professor Drennan has discovered, does still occasionally throw up individuals with brains of enormous size. In the Matjes River site, 300 miles from Cape Peninsula, there were, amongst the skeletons sent to me, no Bushman remains, but there are remains of people showing Bushman affinities. The deepest stratum of the Matjes River site reveals a very remarkable and, as I think, local breed of the pedomorphic race, one tending to assume a curious form of frontal bone—the trigonic form. There is a tendency to trigonism in the modern Bushmen and Hottentots, but not to the degree seen in the oldest Matjes River people. The most important discovery, however, is the presence of a true Boskop skull in the upper Mossel Bay strata. As yet the cultural date of the original Boskop skull is unknown. It may prove—very likely it will prove—to be older in date than the representative found in the Matjes River Shelter, yet the specimen found by Professor Dreyer is the oldest example for which a cultural dating can be given. Then in the same stratum came another skull which serves to link the true Boskop type with what may be called the Strandlooper and Hottentot types. Later still, in deposits of Wiltonian date, comes a child's skull, a replica of the Boskopoid type of Zitzikama described by Professor Dart. It would be well to speak of such a type as that of Zitzikama. To explain the sequence of types in the Matjes River deposits, it seems most feasible to assume not a sudden replacement of stocks, but the local evolutionary transformation of the same stock through a long period of time. No doubt local tribe may have ousted local tribe, and local

exchanges may have been made in the giving and taking of mates, but I see no complete break in the racial series in passing from one stratum to another. The Strandloopers seem to me the lineal descendants of the original people. The origin of the Bushman and Hottentot have to be sought for from the same stock but in other regions of South Africa than the central and southern parts of the Cape Province.

TABLE I.

Dimensions of Skulls from Matjes River Shelter.

	Sex.	Age.	A.	B.	C.	D.	E.	F.	G.	H.	J.	K.	L.	M.	N.
M.R. (1) 30 ft.	♂	20–25	193	97	96	114	131	135	120	19	103	90	102	70	1400 c.c.
M.R. (2) „	♀	2½	163	..	..	110	124	112	..	..	94	84	84	76	..
M.R. (3) 20 ft.	♂	3½	162	77	85	109	129	125	102	15	100	86	90	79	..
M.R. (4) 12 ft.	♂	30–40	203	100	103	124	149	140	116	22	126	102	106	73·4	1660 c.c.
M.R. (5) 10 ft.	♂	50+	201	100	101	118	135	132	120	27	120	96	112	67·1	1490 c.c.
M.R. (L) .	♀	25–30	178	..	..	116?	118	..	..	..	105	94	108	66·6	1230 c.c.
M.R. (O) .	♀	2½	172	80	92	102	120	109	92	14	94	86	86	69·7	1050 c.c.

A. Glabello-occipital length.
B. Pre-auricular length (on Frankfort plane).
C. Post-auricular length „ „
D. Highest point of vault (above Frankfort plane).
E. Upper parietal width.
F. Lower parietal width.
G. Bimastoid width (over bases of mastoid).
H. Length of mastoid process (measured from Frankfort plane).
J. Maximal frontal width.
K. Minimal „ „
L. Supra-orbital width of frontal—measured between lateral ends of supra-orbital processes.
M. Cephalic index.
N. Estimated cranial capacity.

[TABLE II.

TABLE II.

Lengths and Curvature of Bones of Vault.

	Frontal.			Parietal.			Occipital.		Transverse arch.	
	A.	B.	C.	D.	E.	F.	G.	H.	K.	L.
Boskop skull .	150	..	..	139	..	..	..	..	8·5	7
M.R. (1) 30 ft.	130	..	..	135	122	25	70	46	17	20
M.R. (2) ,,	124	100	30	110	99	22	100	55	15	16
M.R. (3) 20 ft.	118	97·5	27	118	104	24	72	60	15	15
M.R. (4) 12 ft.	145	122	30	130	116	27	112	70	13·5	9·5
M.R. (5) 10 ft.	136	120	27	120	112	21	72	57	..	..
M.R. (L) .	130	112	32	125	110	26	..	..	15	15
M.R. (O) .	125	100	34	121	107	26	112	56	..	..

A. Length of sagittal arch of frontal bone.
B. ,, chord of sagittal arch of frontal bone.
C. Height of sagittal arch of frontal bone.
D. Length of sagittal arch of parietal bone.
E. ,, chord of sagittal arch of parietal bone.
F. Height of sagittal arch of parietal bone.
G. Length of occipital arch preserved.
H. Distance from inion to lambda.
K. Height of transverse arch of frontal 35 mm. from bregma.
L. ,, ,, ,, ,, 70 ,, ,, ,,

(See p. 154 for explanation.)

TABLE III.

Measurements of Mandibles.

	Sex.	Age.	A.	B.	C.	D.	E.	F.	G.	H.	J.	K.	L.	M.	N.
M.R. (1) 30 ft.	..	..	42	43	63	56	24	19	34	17	108	7	108	104	111
M.R. (3) 20 ft.	..	..	30	30	43	41?	18	13	23·5	11·5	..	..	..	..	..
M.R. 21 ft. .	..	..	32	44	59	58	24	17	..	..	95	..	..	..	..
M.R. 15 ft. .	..	..	41	41	63	50	24	19	31	18	104	9	..	..	..
M.R. (X) .	♂	..	35·5	43	62	52	22	15	35	15	102	1	105	..	..
M.R. (15) .	♂	..	41	41	63	50?	24	19	31	17	104	9	110	106	125
M.R. (*nn*) .	♀	12 yrs.	31	35	52	47	23	15	25	12	93	7	..	91	113
M.R. (*an*) .	♀	..	..	..	..	..	23	18	33	14	..	..	..	..	..
M.R. (*ann*) .	♀	..	..	..	..	..	23	13	28	11	..	..	..	..	..

A. Minimal width of ascending ramus.
B. „ height.
C. Condylar length.
D. Coronoid length.
E. Depth from alveolar to lower border at m^2.
F. Greatest thickness.
G. Depth of symphysis.
H. Greatest thickness (a.p. diameter) at symphysis.
J. Projection of chin.
K. „ „ in front of median alveolar point.
L. Bicondylar width.
M. Bigonial width.
N. Outer circumference of mandible.

This paper is published with the financial assistance of the Carnegie Corporation and the Research Grant Board.

THE ARCHAEOLOGY OF THE MATJES RIVER ROCK SHELTER.

By T. F. Dreyer,* Grey University College, Bloemfontein.

(With seven Text-figures. Reduced to one-third.)

The Matjes River enters the sea about four miles east of the well-known Keurbooms River in the Knysna district. The Rock Shelter referred to in this paper is situated right at the mouth of the river on its west bank.

The situation of the shelter is such that it has the advantage of the warming rays of the sun during practically the whole day. Its floor is a few hundred feet above the level of the river-bed and is nearly 100 yards long by about 25 feet wide in the centre.

When the writer first visited the shelter the surface at the southern end of the shelter was largely (especially near the face of the cliff) covered by a 6-inch layer of rock fragments that had fallen down from the cliff face. In the central portion there had apparently been a fairly extensive, 3-foot thick, layer of ashes and weed bedding, but only a small area of this layer, with steep sides, was left undisturbed. From it a few badly rotted skeletons, two bits of coarse pottery, and an ornamented bone tube were recovered. This layer will be referred to as M.R., A.

M.R., A. I. Skeleton.

None of the skeletal parts from M.R., A. were submitted to Sir Arthur Keith. They were all of a small (Bushman) race, and one skeleton is sufficiently complete to be useful.

Sex.—The sacrum is of that same long, narrow nature characteristic of other pygmy skeletons in the writer's collection (very different to the massive, roughly triangular sacra from the deeper levels), and its curvature indicates that the skeleton is that of a woman.

Size.— Femur length = 32·5 cm.
Tibia length = 26·5 cm.
Humerus length = 23·1 cm.

* The author acknowledges the financial assistance of the Research Grant Board.

Shrubsall's * lowest figures are : femur 36·7, tibia 29·8, and humerus 25·3 ; Slome's† shortest lengths are : femur 36·1, tibia 30·3, humerus 25·0.

The M.R., A. I woman is thus a true pygmy of a stature well below the lowest recorded.

Lower Jaw.—The ascending ramus has the shape characteristic for Bushman ; the minimum height is 31 mm.—the same as the minimum breadth. There is a distinct chin triangle, but, if the alveolar border be placed on a horizontal, then the chin does not reach the vertical drawn from the anterior end of the alveolar border. There is a deep genial pit, without noticeable tubercles. The premolar-molar length is 44 mm. and the second molar is 10·5 mm. broad. The thickness of the jaw at the level of the second molar is 25 mm. and 11 mm. at the symphysis. The symphysial height is 31 mm. Both first and second molars have a fifth cusp.

The lower jaw is fairly typically Bushman.

Skull.—Most of the face is lost. The forehead is not characteristic of the prehistoric South African race in which Sir Arthur Keith includes the Bushmen. The supra-orbital ridge is faintly indicated as a transverse ridge in the glabellar region. The peculiar shelf-like development of the supra-orbital and the groove which separates it from the ascending tabular part of the frontal is not shown by this skull, and this characteristic of the lower-level Matjes River skulls is not distinct either in the writer's own collection of Bushman skulls nor in skulls seen in the collections of South African museums. Also, the grooves in the frontal bone caused by the deep course which the supra-orbital nerve takes are not very distinct. The forehead is high, but there is a distinct ridge on the site of the metopic suture, and the frontal bosses are not prominent. Just behind the orbit there are those distinct swellings (enlarged lateral lobes of the frontal region of the brain) which Dart first pointed out as being characteristic of Bushman skulls.

The upper edge of the temporal has that low course characteristic of Bushmen and of the prehistoric South African skulls. The mastoids are minute. The parietal bosses are very moderately developed, and the cranial wall between them, as seen in *norma occipitalis*, is well arched—not almost flat as in the Matjes River race.

The cerebellar region is very full.

The length of the skull is 178·5 and the breadth (high up near the parietal bosses—lower down it is considerably less) 127 mm., so that the cephalic index is 71. The auricular height is 105 mm. The minimum and maximum frontal diameters are 88 and 109 mm.

* " Notes on some Bushman Crania and Bones," Ann. S. Afr. Mus., vol. v, 1907.

† " Osteology of a Bushman Tribe," Ann. S. Afr. Mus., vol. xxiv, 1929.

Only one malar is present, and its position shows that the cheeks were prominent in front, as is usual in Bush skulls.

M.R., B.

The Second Layer was composed very largely of mytilus shells and can be called the mytilus layer or M.R., B. It is about 8 feet thick.

The implements obtained from this layer are :

1. Rough stone fragments similar to what has been described from kitchen-middens of this coast.

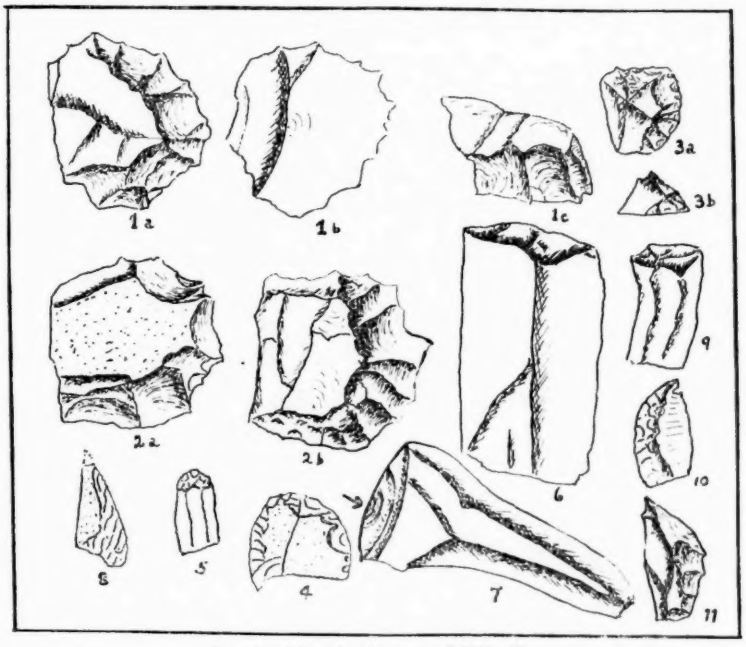


FIG. 1.—Stone implements of M.R., B.

1*a*, 1*b*, and 1*c*, Upper, lower, and side views of a high-backed scraper (chalcedony).
2*a* and 2*b*, Upper and lower surfaces of a core-scraper (chalcedony).
3*a* and 3*b*, Upper and side views of a small core-scraper (chalcedony).
4 and 5, End-scrapers (crystalline quartz).
6, End-scraper (quartzite).
7, Keeled point with burin (?) blow at point (chalcedony).
8, Point of crystalline quartz.
9, End-scraper of chalcedony.
10, Crescent of crystalline quartz.
11, Crescent of chalcedony.

(Reduced to ¼.)

2. Mullers and grinders.

3. One flat polished kwê-stone, the hole of which had been commenced on both sides ; it is of hard, sandy shale. Disintegrated parts of two other similar stones of soft laminated shale.

4. Seven roughly-shaped (circular, oval, and horseshoe shaped) shale palettes.

5. Small stone implements as follows :—

(*a*) *Scrapers.*—(1) Two end-scrapers of quartzite, about 35 mm. long by 23 mm. broad. They are similar to Smithfield B. duckbills in shape, but the secondary trimming at the ends is very rough.

(2) A small end-scraper (17 mm. long) of chalcedony of the same type.

(3) A small, flat, round end-scraper of chalcedony of about the size of a threepenny-piece. The secondary trimming at the end is quite good and produced a saw-edge.

(4) Several almost round scrapers of crystalline quartz and chalcedony, 10 to 22 mm. in diameter. Secondary trimming rough.

(5) Two single crescents of chalcedony, 17 and 30 mm. in length respectively. Each has one end terminated abruptly and the other end sharply pointed.

(6) A small core-scraper, 9 mm. long and 12 mm. broad. The fluting-flake scars terminate in a high point (6 mm.) and the end is beautifully trimmed. Another core-scraper of similar size has no secondary trimming and is not so high. A third core-scraper is about 25 mm. in diameter.

(7) A flake of crystalline quartz with two crystal faces on one side and a flake surface on the other has its edges beautifully trimmed in a way reminding one of the best Smithfield style. Another flake of crystalline quartz (12 × 8 mm.) has been exquisitely formed without making use of the natural crystal faces ; the top surface shows three parallel fluting-flake surfaces, and the end is delicately trimmed. When one remembers how refractory crystalline quartz is, one cannot but marvel at the expertness of the makers of such implements and stand astounded at the imperfection of their larger tools.

The writer assumes that the presence of, and the preponderance of, scrapers, made in the Smithfield way, and the presence of crescents, indicates that the M.R., B. layer belongs to the Smithfield C.

M.R., B. Skeletons.

One fragment of a cranium from this layer was submitted to Sir Arthur Keith [M.R. (L.)]. The reason for sending this fragment, instead of the more complete skulls, was the lack of prominence of the frontal bosses and the amount of lateral projection of the zygomatic processes of the frontals—points which Sir Arthur Keith stresses.

From this same layer comes (besides other fragmented parts) two complete (whole) skulls from the lowest level and two similarly complete skulls from near the top of the layer, together with portions of the rest of the skeletons.

The lowest level of M.R., B.

The skull of both the man (M.R., B. I) and of the woman (M.R., B. II) have the following resemblances :—

1. The foreheads are similar to that described by Sir A. Keith as M.R. (L.).

2. The nasal bones are flat and the nasal aperture is small and faces forwards ; it is rounded.

3. The orbits are long and narrow.

4. There is considerable subnasal prognathism.

5. The teeth are fairly large, *e.g.* the second lower molar of the man is $12{\cdot}3 \times 12$ mm., the corresponding tooth of the woman being 11×11 mm., *i.e.* very distinctly above the average for Bushman as given by Drennan,* and even above that for Bantu (J. C. Middleton Shaw : The Teeth, The Bony Palate, and the Mandible in Bantu Races of South Africa).

6. The lower jaw of the woman has the square ascending ramus that is typical of Bushman (breadth 39·4, height 41·4), but that of the man is $30{\cdot}9 \times 36{\cdot}5$ mm. Both have the pointed, but not prominent, chin of the Bushman.

7. The crania are very similar, viewed from all aspects. The parietal bosses are very prominent, but do not give rise to that flatness on top which the M.R., D. race, shows in *norma occipitalis*.

8. The mastoid processes are strongly developed, especially in the woman's skull, which also shows very strongly-marked temporal lines.

9. The upper edge of the temporal bone has the low outline stressed by Sir A. Keith, with its highest point near the anterior extremity.

10. Both skulls are moderately thick-walled—much thicker than those of modern Bushmen.

11. Both show the temporal swelling behind the orbit, already mentioned as characteristic of the Bush race.

	Length.	Breadth.	Auriculo-bregmatic Height.
Man . . .	179	137	108·5
Woman . .	183	136	104

* " Dentition of a Bushman Tribe," Ann. S. Afr. Mus., vol. xxiv.

Stature.—The long bones of the woman had the following lengths and were robust: femur 435 mm., tibia 355 mm., humerus 315 mm., radius 225 mm. The tallest Bushwoman tabulated by Slome * is No. 7, whose femur measured 433, tibia 355, humerus 305, and radius 241 mm.

Method of Burial.—The skeletons were found on their sides with a few stones over the skulls; the knees were under the chin. The woman's skull was encased in a thick layer of powdered ochre, but the man's skull showed only a small amount of powdered ochre.

These Smithfield C. (or Wilton ?) people may be taken to be a Bush race of a taller, more robust build than the modern race, the only peculiar features being their prominent parietal bosses, well-developed mastoids, and very narrow, slit-like eyes. They rather seem to favour Broom's † view that the modern Bushman is a degenerate descendant of well-developed ancestors.‡

The two skeletons in the upper portion of the mytilus layer are both women. They are by no means pygmies, although small, and are much more like one's accepted views of what Bushman skeletons should be like.

Besides these, the writer has another skull, M.R., B. III (without the rest of the skeleton and without teeth), found in his absence from the cave. From the explanations of the native workers, it must be either from the base of the Smithfield layer or from just below it. In this connection it must be mentioned that the woman (M.R., B. II) mentioned above was not actually in the mytilus layer, but buried from a mytilus level in the layer below it. M.R., B. III is very similar to the two Smithfield people, M.R., B. I and M.R., B. II, except that the forehead is straighter—due to a very depressed glabellar region—and that the nasal bones curve upwards to some extent at their lower ends.

M.R., C.

Below the mytilus layer there is a layer of black loam about 2 feet deep, with a very distinct race. One injured skull of this race is described by Sir Arthur Keith [M.R. (5)].

In making the first excavation in the Matjes River Shelter, the writer overlooked the difference between this layer and the one below it. How-

* "Osteology of a Bushman Tribe," Ann. S. Afr. Mus., vol. xxiv.

† Dr. R. Broom: "The Yellow-skinned Races of South Africa," R. Anthr. Inst., vol. liii.

‡ I would like to take this opportunity to say that the surmises as to the identity of two skulls mentioned by Broom in the above publication, which will be found in the paragraph at the top of p. 83 (Trans. Roy. Soc. S. Afr.), are mere surmises based on statements made to me, and that I accept Dr. Broom's statement that the surmises are incorrect.

ever, in describing the skulls, he * could not " place " one skull, and said of it (on p. 52) : " M.R. (5) is an anomalous skull." It seemed to the writer rather like a Bantu woman's skull except for the very flat nasal bones.

In this layer the writer found, during the second excavation of the cave, six fairly complete skulls (one of which was sent to Sir Arthur Keith) besides a number of incomplete fragments showing the same features. Sir Arthur sees in this race (as represented by the one skull available to him) another local breed of the South African stock, or only a normal variant of the local race ; and states that the fragment of skull from the mytilus layer (M.R., L.) may very well be a female of this same race.

It is unfortunate that Sir Arthur only saw one of these skulls and only one adult skull of the writer's Matjes River race ; if he had seen the two series he would at once have seen that the two skulls he has described are not merely normal variations of the same type. The Matjes River race is typically brachycephalic (in this respect the skull sent to Sir Arthur is not typical)—the M.R., C. race typically dolichocephalic ; the first race has very prominent parietal bosses, the second without this character ; the first shows some large heads but also some very small broad ones, the latter are all large with very massive cranial and other bones ; the first has straight " Bushman-like " foreheads, the latter (except for one female skull) with foreheads like the Bantu ; the former has the peculiar dorsal flatness of the head as seen in *norma occipitalis*, the latter with heads Bantu-like, or shall we rather say European-like, in occipital view ; the former showing, as Sir Arthur points out, flattish faces, the latter more European-like cheek-bones.

The two series disposes of one of Sir Arthur's possibilities, viz. that the M.R., C. race is a normal variation of the South African race as represented by the Matjes River type. The other possibility, that it represents the arrival at Matjes River of a new local variety of the South African type, will have to be discussed when these skulls are described in detail.

As already mentioned above, the distinctness of this layer was not recognised during the first visit to the shelter. Even now the writer is not absolutely certain as to its cultural contents. The Smithfield people, when first occupying the shelter, buried their dead in and on this layer, and since the layer (M.R., C.) is comparatively shallow, it is difficult to be quite certain as to the date of small objects found in it. They may have been brought into the layer by disturbance of its upper surface on the part of the Smithfield people.

As far as *burial rites* are concerned, it can be said that there is a clear distinction between the two. The lowest Smithfield burials (M.R., B.)

* " Fossil Man and Mammals from South Africa," Dreyer and Lyle (G.U.C., Bloemfontein).

disposed the body in a sleeping attitude (as for M.R., C.), and placed a few stones over the head (also as for M.R., C.). But the Smithfield folk, unlike the previous occupants of the shelter, poured powdered red ochre over the head ; and the M.R., C. folk, unlike the Wilton, placed an ostrich egg-shell, with a hole at the top end, upright next to the head. Ochre, in quantity, seems to have acted as an excellent preservative for the bones covered by it, so that the lower M.R., B. skeletons are much better preserved than any of the M.R., C. skeletons.

The differences in the burial ritual seems thus to indicate—like the skeletons—two different races, or, at least, local races.

Stone and other Implements.

*Wood.**—Five wooden artefacts were found. The wood is of a peculiar satiny texture and splits readily along exceedingly smooth planes. If immersed in water, or washed, it splits into thin plates. If ignited for a long period in a gas-flame it does not powder, but retains its shape (and, apparently, its size), and becomes hard and brittle—the residue being $CaCO_3$. The wood must therefore be heavily mineralised with lime.

The first artefact is, from its size and shape, apparently a woman's "apron." It is a thin sheet of wood, with the grain not parallel with, but oblique to, the surface. It has a hole drilled in it, and its edges are polished down to a thin edge. It is concave transversely (but flat from upper to lower edge) on one side and similarly convex on the other surface, and the edge on the convex surface is ornamented by incised lines.

The second wooden object is apparently a wooden bodkin. Its point is broken off so that it cannot be definitely called a bodkin, but from the way it is flattened towards the broken end it seems to have been such.

The other three wooden objects are : one whole, and fragments of two other, large beads shaped just like the kwê-stone to be mentioned later. The whole one is 33 mm. high, with a hole which has been bored from both sides so that it is hour-glass shaped. It is not symmetrical, the diameter being 32 mm. in one plane and 35 mm. in a plane at right angles to that. The hole is bored in the direction of the grain.

These three "beads," together with the two other wooden implements (and the shell ornaments and the kwê-stone), were all found in close proximity to one of the M.R., C. skulls, and the writer assumes that the wooden beads were worn as a necklace—the very small kwê-stones, sometimes explained as children's toys, may then also be explained as necklace stones.

Shell Artefacts.—Six oyster shells, each with a single hole bored in it, and with the edges ornamented by incised lines, were also found with the wooden implements already mentioned.

* What is here described as wooden implements may be—probably is—ivory.

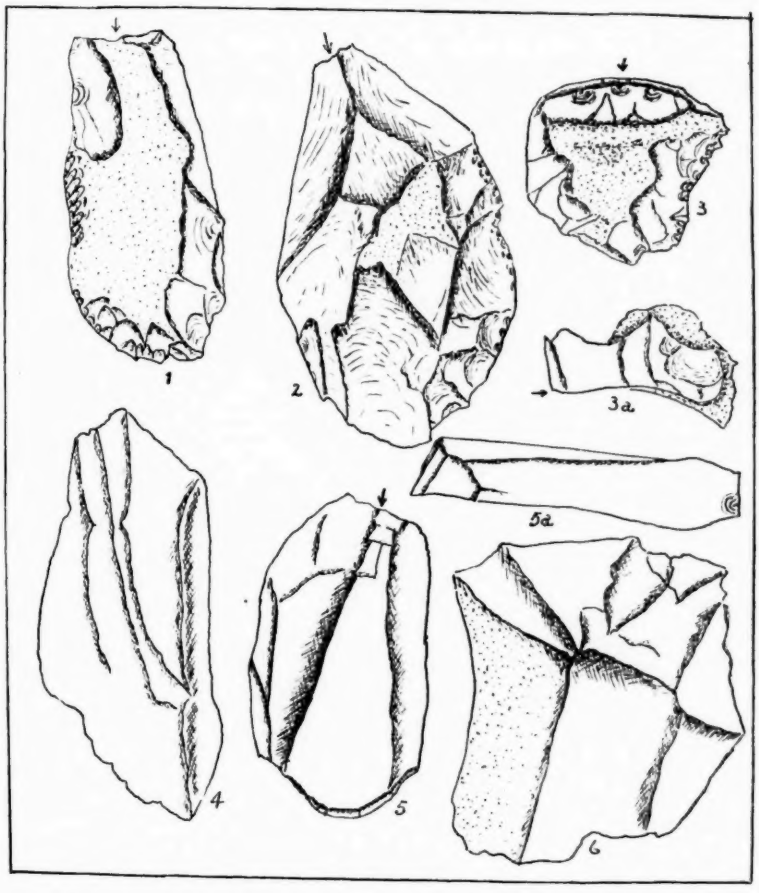


FIG. 2.—M.R., C. Stone implements found in a " Factory Site " at same level as bone, ivory, shell, and teeth artefacts.

1–3, Scrapers (chalcedony).
4, A core (chalcedony).
5, 5*a*, A trimmer (quartzite). 5, Seen from fluted face ; 5*a*, from side.
6, An anvil (quartzite).

(Reduced to ¼.)

Bone Artefacts.—(1) Two very sharp needle-like awls made of the long bones of large birds were found.

(2) A fragment of polished bone with a sharp, polished edge may very well be part of an "apron" similar to the wooden one, except that the edge is not scalloped.

(3) One thick bone with a polished chisel-like edge, and apparently used for preparing skin, was found.

(4) Three canines of Potamochoerus with holes drilled in their bases were found together.

(5) A piece of polished bone 52·5 mm. long, with both ends tapered, has a cross-section in its centre which is a rectangle with rounded points, the sides of the rectangle being 5 mm. and 7 mm. It may be that it was used as a "fastener" for skin—like a pin—or it may be the neck-piece of an arrow.

Stone Artefacts.—(1) A shale palette about 5 mm. thick with thin sharp edges and beautifully shaped as an elongated oval. The one side seems to be a natural cleavage face, only slightly polished, but the other side is polished all over. It is 196 mm. long by 78 mm. across the middle.

(2) A plate of shale (±5 mm. thick) in the form of an isosceles triangle with a height of 160 mm. and a base of 82 mm. The base is rough and shows that it was first cut on both faces and then broken off. The other two edges are ground down to a fairly sharp edge. The polishing, both surfaces, must have been done with a coarse stone, since the surface is densely scored by heavy lines, more or less parallel to the long axis of the implement.

(3) A kwê-stone, 80 mm. in height and 82 mm. in circumference, with a hole bored almost wholly from one side (the hole is 40 mm., and 32·5 mm. in diameter at the two ends), and consisting of quartzite, was found with the bone implements already described. Its surface is, to some extent, polished, but still shows numerous pitmarks, showing how it was shaped by "picking."

(4) Just to the south of, and at the same level as the skull and wooden, etc. implements mentioned above, there was a heap of chalcedony fragments—apparently the site where a large block of this stone was broken up and tools made. Amongst this chalcedony fragments there were two "anvil" stones and a trimmer of quartzite. The anvil stones are flat on one face with the opposite face trimmed so as to produce a high point near the centre of the face; this point was fractured. The trimmer is a thick flake with its point steeply flaked.

The chalcedony was veined by crystalline quartz and had cavities filled by earthy minerals and was apparently not very suitable as a medium for the manufacture of implements, its fracture being very irregular. The

recognisable artefacts were (*a*) 4 cores with prepared striking platforms —one of them was used subsequently as a polisher; (*b*) 4 scrapers with some part of the side minutely trimmed.

These implements are, to the writer, rather suggestive of the Smithfield A. artefacts. They have been placed in an isolated group, since they can be described as coming from a sort of factory site. The other implements, as already mentioned, may not all be of this layer, which is thin and may have, included in it, implements brought into it either by disturbance of the lower layer—which is in no way clearly marked off from it—or by digging into it by the folk of the layer above it. The number of burials in a very confined area makes both kinds of disturbance (and inclusions) quite possible. With this proviso, the following list of stone implements from layer M.R., C. may be given :—

1. *Larger Implements.*

(*a*) Backed blades : stout points with one edge blunted and the point broken off. There are three such : in one the blunt back was merely the natural rock surface ; in the second the blunt back was produced by removal of large rough flakes along the whole edge so as to produce a large crescent-like implement ; in the third the blunt back was formed by striking off a flake, from the striking platform, in a direction at right angles to the ventral surface of the implement.

(*b*) A blade without secondary trimming.

(*c*) End-scraper made on a flat blade.

(*d*) A stout, short blade with one side flaked by use (the small flake scars extend to both the ventral and dorsal surfaces of the edge—was this edge used as a fabricator in the sense used by Leakey ? *) and the other edge removed by a long flake (as Leakey suggests that his fabricator edges are removed when useless).

(*e*) A short, almost round, flake, with one edge showing a similar used appearance.

(*f*) A rounded, strongly flaked artefact, such as, in South Africa, are usually called fabricators, but which Leakey assumes were used as sling-stones.

(*g*) A thick, flat disc with step-flaking at the end opposite to the bulb of percussion, and thus used as a hammer-stone or as a trimmer.

(*h*) A thick, wedge-shaped quartz end-scraper.

Of these implements only one (namely, *a* 3) has a distinct prepared platform. In *a* 2 and *c* it is very doubtful if there is such a platform or not, whilst in *a* 1, *b*, *d*, and *e* the striking platform is the original rock face.

* Leakey : The Stone Age Cultures of Kenya Colony.

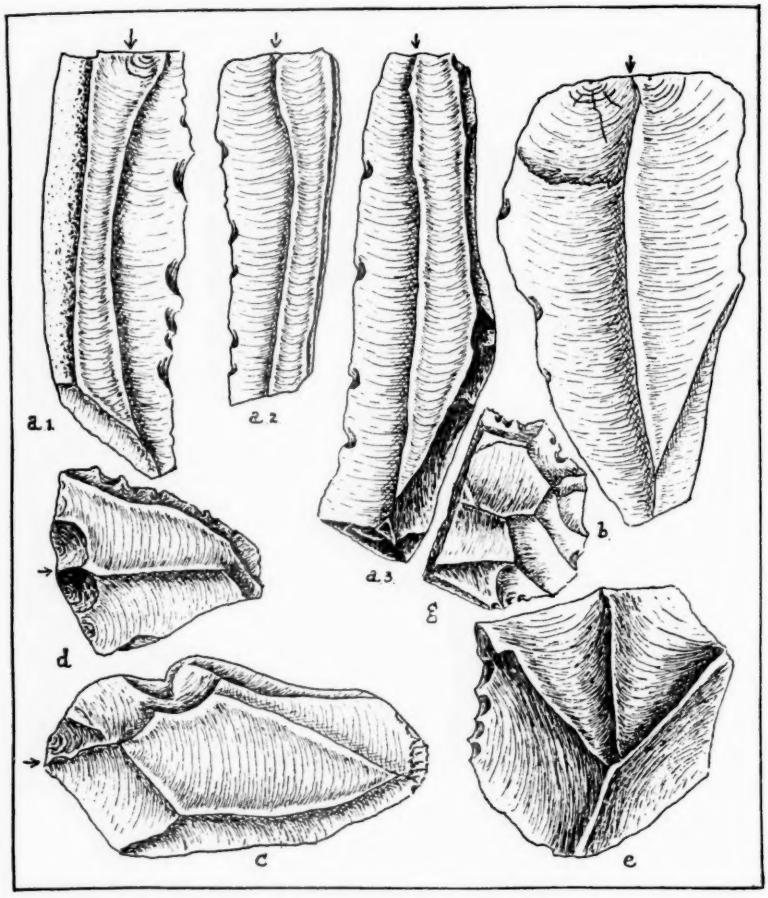


FIG. 3.—M.R., C. Larger implements from M.R., C. layer.

a 1, *a* 2, *a* 3, Blunt-backed blades (quartzite).
b, Blade (quartzite).
c, End-scraper (quartzite).
d, Fabricator (?) in sense that Leakey uses term (chert).
e, Same (quartzite).
g, Scraper (quartz).

(Reduced to ¼.)

The angle between the striking platform and the single-flake face is larger than a right angle—*i.e.* in this respect like Middle Stone Age flakes (according to Goodwin *), but the writer has a number of undoubted Smithfield A. flakes (*i.e.* New Stone Age flakes) resembling the Middle Stone Age flakes in this respect.

The implements are rough and few in number; the only definite type is *a* 2, which is apparently of the nature of a giant crescent such as Hewitt has described from Howieson Poort.

2. *Small Microlithic Implements.*

In the case of the large implements, so also here, only those implements will be enumerated which are definitely shaped so as, in the aggregate, to indicate their lithic level. Such are :—

(*a*) Cores (two) of chert, one 20 mm., the other 35 mm. in height. The larger one had, subsequently, been shaped as an end-scraper, and its one edge shows very extensive step-flaking, indicating its use as a fabricator (in Leakey's sense of the term).

(*b*) A flake of white chert with a side edge indicating a similar use.

(*c*) A disc of chert with the end edge step-flaked in the same way. In this case the edge has a crushed appearance and flakes have sprung from it on both sides of the edge.

(*d*) Six distinct and well-formed lunates or crescents (five of chert, one of quartz).

(*e*) Well-shaped side-scraper of chert.

(*f*) Three distinct thumbnail scrapers.

(*g*) Two round scrapers.

(*h*) A number of small high-backed points.

(*i*) A number of wide, flat blades.

(*j*) A notched scraper.

(*k*) A double-pointed borer made by working away the base of a flake (chert).

(*l*) A peculiar side-scraper with two high points on the dorsal surface (chert).

In South Africa the Wilton seems to be a rather heterogeneous group of separate associations: some without pottery (Rhodesia), others with pottery (all Union sites up to the present). Some of the latter sites may have no microliths (see Goodwin †), others have none of the jagged artefacts of the kitchen-middens, whilst still others have both. It seems to be an

* Goodwin: Ann. S. Afr. Mus., vol. xxvii; Stapleton and Hewitt: "Stone Implements from Howieson's Poort," S.A.J.S., vol. xxiv, pp. 574–587.

† "The Wilton Industry," Ann. S. Afr. Mus., vol. xxvii.

industry principally characterised by the presence of small end-scrapers (like those of the Smithfield) associated with lunates.

Now, in Kenya, Leakey * has found these lunates, which we consider so characteristic of Wilton, in a wide range of cultures (from the Palaeolithic

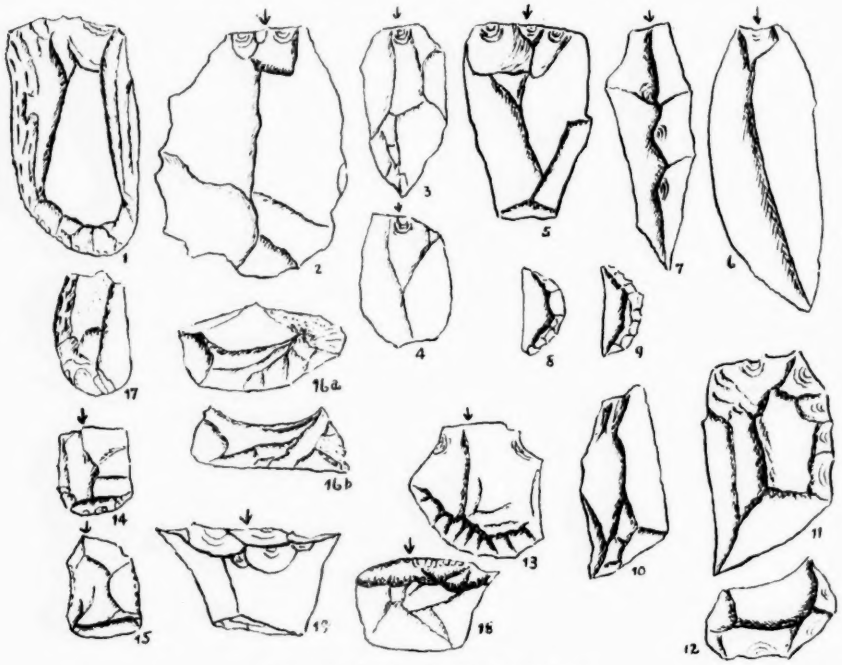


FIG. 4.—M.R., C. Microlithic artefacts.

1, Core used as end-scraper and side as trimmer (chert).
2–6, Blades flat, except 6, which is triangular in section ; all of chert, except 5, which is of quartzite.
7, Sharply ridged point of milky quartz.
8–12, Lunates all of yellow chert.
13, End-scraper (chert).
14–15, End-scrapers of chert.
16*a*, Dorsal view, and 16*b*, Front view of scraper.
17, Chert implement used as end-scraper and with one edge step-flaked (trimmer).
18, A chert flake with the base (opposite to the one-flake surface) worked to an edge.
19, A chert flake with the base steeply worked off so as to produce to boring points.

(Reduced to ½.)

Aurignacian, through the Mesolithic Elementeitam to the Neolithic Gumban). It almost seems as if wherever arrows were made by purely

* Leakey : The Stone Age Cultures of Kenya Colony.

Stone Age folk there the lunate was made to serve as a barb. Van Riet Lowe states that they have also been found on Smithfield sites.

If we now compare the association found in M.R., C. with what Goodwin enumerates as constant associations composing the Wilton Industry, we get the following :—

Wilton.	M.R., C.
1. Crescents.	Crescents.
2. Small end-scrapers.	Small end-scrapers.
3. Thumbnail scrapers.	Perhaps doubtful.
4. Horseshoe scrapers.	(*Absent.*)
5. Pygmy cores.	Pygmy cores.
6. Ostrich egg-shell beads.	(*Absent.*)
7. Bead borers.	(*Absent.*)
8. Bead shapers.	(*Absent.*)
9. Pottery.	Ostrich egg-shell containers.
10. Awls (bone).	Awls (bone).
11. Paint fragments.	Ochre and psilomelane.
12. Grinders and mullers.	Grinders and mullers.
Less constant elements in Wilton :	
13. Painted grave-stones.	(*Absent.*)
14. Bored stones.	Bored stones and similar wooden (or ivory ?) beads.
15. Bone spatula.	*Absent* : one found in mytilus layer but lost in packing.
16. True awls (needle thin points).	True awls.
17. Nacre pendants.	Nacre pendants.
18. Egg-shell pendants.	(*Absent.*)
19. *Not mentioned.*	Side-scrapers.
20. *Not mentioned.*	Shale palettes.
21. *Not mentioned.*	Ivory and bone " aprons."
22. *Not mentioned.*	Stout bone with polished chisel edge.
23. *Not mentioned.*	Macrolithic artefacts, such as blunt-backed blades, trimmers, etc.

The M.R., C. association seems to have been manufactured by a newly arrived race with a microlithic culture which either had skinning knives or borrowed the technique of making such knives from the people that they replaced. If we are to refer this association to the Wilton, then we can state confidently that skulls such as the M.R., C. skulls have never previously been associated with the Wilton—the height of the parietal

region and their ridged and upturned nasal bones very sharply and distinctly separate them from the San stock to whom the Wilton implements are commonly ascribed.

The M.R., D. Layer.

The skeletons from this layer and their method of burial have already been described * as the Matjes River race. It need only be stated here that M.R. (5) of that publication (made at a time when the writer had not recognised that M.R., C. was a distinct layer) must now be taken to be from the M.R., C. layer; it was then already recognised as anomalous, and it is now found to resemble the M.R., C. skulls. As to the implements, microliths are very rare, and the few found are of no definite form—they look more like discarded flakes than like implements.

Sir Arthur Keith writes me that Professor Burkitt does not recognise "Mossel Bay Culture" as a definite and distinct one. I need only say that I used the term in the publication mentioned in the way that Goodwin † uses it—not in the sense of van Hoepen.‡ Goodwin has recognised "Mossel Bay" as a distinct Middle Stone Age Industry, and that the Matjes River race were the makers of this type of implement will be seen from the following description.

It may be said at once that although the Matjes River race (M.R., D.) is separated from burials right at the base of the deposit by a thick layer of ashes and soil in which there are no burials, the same type of implements occur throughout, from the M.R., D. layer to the base; any differences there are (such as a number of side-scrapers and two definite lance-heads near the base) may perhaps be due to the fact that the stone implements are quite rare in the M.R., D. layer and fairly numerous about 18 inches to 2 feet above the base of the deposit (M.R., E. layer). It does, as a matter of fact, seem as if end-scrapers are more common and more like those of Smithfield A in the M.R., D., and that side-scrapers are only found in the M.R., E. layer; also, that true lance-head types are only found in M.R., E. and not in M.R., D.; but the total number of implements is too small for the writer to speak with certainty on this apparent difference.

It seems, thus, best to treat the whole deposit below the M.R., C. layer as one and to mention the depths at which the various implements were found in each case. Even here there may be a difference of up to 3 feet in the depths given, since I always allowed for the 3 feet of the M.R., A. layer, whereas my assistant did not make this allowance. This

* Goodwin: "Chronology of the Mossel Bay Industry," S.A.J.S., vol. xxvii, p. 562.

† Dreyer: Mammals and Man from South Africa.

‡ van Hoepen: Argeologiese Navorsing, Nat. Museum, Bloemfontein, decl. i, pt. 4.

difference in level, however, only refers to the layers below M.R., C., and does not seem to be of great importance. Before unpacking the parcels I could even make the necessary corrections, but now that they have all been placed together the only criterion is the label on each implement.

Bone Implements.—(*a*) Two flat bones with polished faces. Evidently used as polishers.

(*b*) Two bone tubes. One 40 mm. long with the ends rounded by polishing; the other, 90 mm. long, is a carpo-metacarpus of a bird with the ends polished down so as fully to expose the cavity.

(*c*) Five splints of bones, each with the end scraped and polished to a fine point (awls).

(*d*) Five splints of very large bones, each with one end scraped and polished to a fine chisel edge. The edge has somewhat the shape of a duckbill and is sharp, but the two polished faces form a rather large angle with each other, so that the edge is a strong one. As the edges show no signs of use, they may be taken to be implements for preparing skin.

These implements are all from M.R., D., *i.e.* from above the sterile (*i.e.* skeletons absent) layer between M.R., D. and M.R., E. From M.R., E. came a similar, but rougher, chisel point and four splints of bone with thick points (rough, blunt awls).

Shell Artefacts.—In association with the skull from the base of the deposit (M.R. (1) of Sir Arthur Keith) were a large number of shell beads. These varied in diameter from 3·5 to 6 mm., and were somewhat angular (not circular) in outline. Their outer edges are rounded. The boring was done from both faces—apparently by means of a short (*i.e.* sharply tapering) point. Such a point was, in fact, found in M.R., E. It is a flat flake (2 mm. thick) of milky quartz, 18 mm. long and 5 mm. across the middle line; it has been carefully trimmed, by the removal of numerous flakes at right angles to the two faces, to the form of a *double crescent.* This was the only well-formed microlithic implement showing secondary trimming in the whole deposit below M.R., C.

Large Stone Implements.

(*a*) *Trimmers.*—Three trimmers, somewhat resembling those so common on Smithfield A sites were found.

(1) The first (16 feet) is triangular in section, 62 mm. long by 25 mm. broad. Its end has been trimmed somewhat like the duckbills of the Smithfield culture, and its anterior edge is step-flaked by use.

(2) The second (25 feet) has a lower flat surface of original rock face; its upper surface is roughly trimmed so as to be roughly semicircular in section, its one end is shaped (by trimming) to form a strong, heavy working

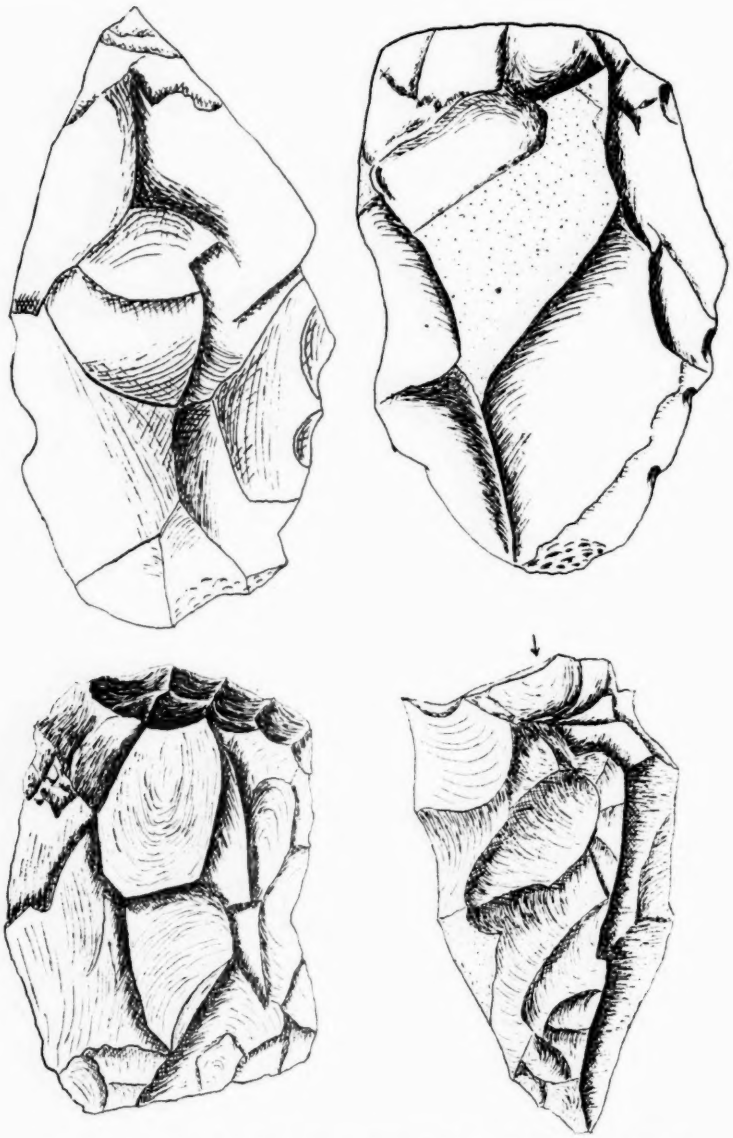


FIG. 5.—M.R., D. and E. artefacts, viz. two *coup-de-poing*-like hammer-stones; a trimmer (lower left), and a giant crescent-like blade (lower right).

(Reduced to $\frac{1}{3}$.)

face (*cf.* van Hoepen's * Afwerker of Koning), and its end edge is step-flaked by use. These two are both of quartzite.

(3) Another trimmer (±24 feet) is of chert, has a resemblance to number 2, but is smaller (50 mm. long, 45 mm. broad, and 25 mm. high), and has the edge both at the end and along the sides step-flaked by use.

(*b*) *Hammer-stones.*—One typical hammer-stone (±25 feet) still so little used that the original pebble face shows as an almost continuous band around it. The edges are "crushed" everywhere by use. It is about 82 mm. in diameter.

A second one (±17 feet), also of quartzite, was almost like a rough *coup-de-poing*. It is 100 mm. long by 60 mm. across its middle and pointed at both ends. The one face is an unworked flake surface (with the bulb of percussion in the centre of the lateral circumference—between the two points—and the other face is coarsely flaked.

A third one (±18 feet), of chert, is even more like a hand-axe in shape (95 mm. by 72 mm.).

A fourth (±25 feet), of quartzite, is like a very rough Stellenbosch boucher (125 mm. by 80 mm.).

(*c*) *Scrapers.* (1) *End-scrapers.*—There are five well-made end-scrapers from the upper level (±18 feet). They are all made from blunt-backed blades, and all have the prepared striking platforms typical of the Middle Stone Age. Only a single well-made end-scraper comes from the deeper level (±26 feet); it is quite similar to the others, but the blunt back is represented by the original pebble face.

(2) *Side-scrapers.*—The only side-scrapers found are from the lower level (26 feet to base). Three are made from broad, flattish blades; one is made from a blunt-backed blade; and the fifth (quartzite, like all the others) seems to have been struck from a *tortoise core*.

(*d*) *Points.*—Eight "points," with prepared striking platforms and three fluting flakes on the dorsal surface, and some with the base thinned by the removal of a few flakes from the dorsal surface, all come from the deeper level (M.R., E.). A few broken bases of similar points come from the 15–20-foot level.

(*e*) *Blades.*—There are two very large blades—one, the broken one, from the base of the deposit; the other from the 18-foot level. These show a good deal of trimming at the base; the one from the deeper level only on the fluted surface, the other on both surfaces.

(*f*) *Blunt-backed Blades.*—Nine blades, some broad and flattish, others long and thick, have their backs blunted by the removal of a flake along one edge. Only one of these is from the upper level. They are all of quartzite except one, which is of a yellowish translucent chert. This

* van Hoepen: Argeologiese Navorsing, Nat. Museum, Bloemfontein, decl. i, pt. 1.

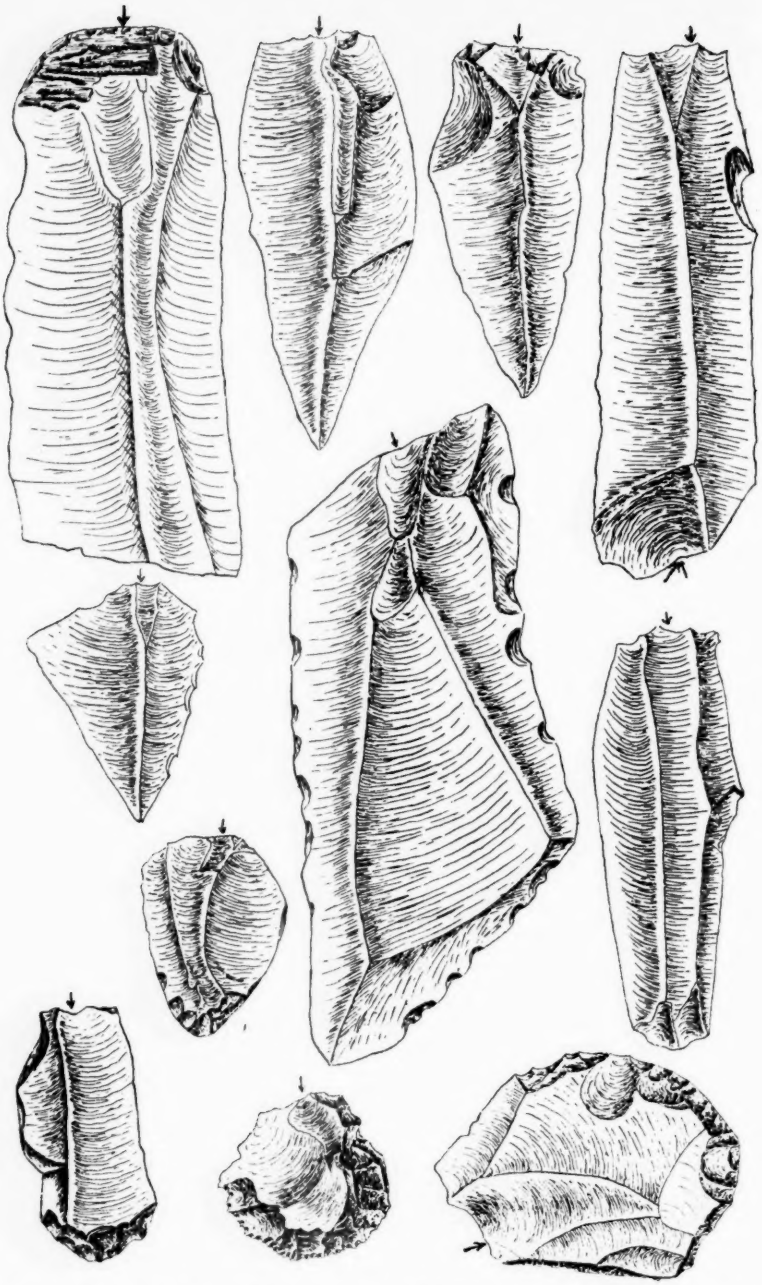


FIG. 6.—M.R., D. and E. artefacts. Two spear-points (top centre), both showing thinning of base (above bulb). A large blade (broken), with thinning of base above bulb (top left). A long triangular blade with a chisel edge (both burin-blow scars are distinct). In middle row is a small spear-head, a very large flat blade, a blunt-backed blade, and an end-scraper made from a small blade. The lowest row shows an end-scraper (blunt-backed blade), a side-scraper with saw-edge, and a large side-scraper (from blunt-backed blade).

(Reduced to ½.)

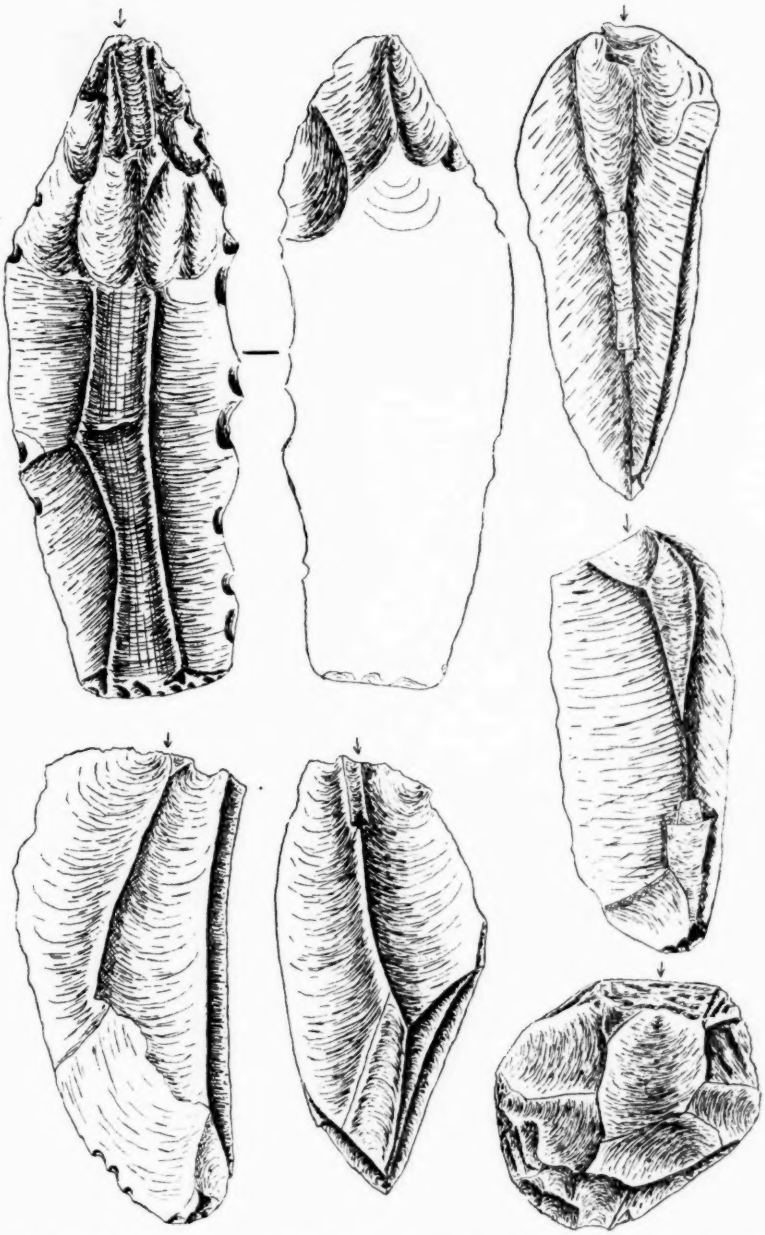


FIG. 7.—M.R., D., and M.R., E. artefacts. A blade (top left and centre) with base worked away and point showing use-scars. A blade (top right) with base thinned on dorsal face and point strengthened by burin (?) blow. Three other blades, two with rounded points, for easier use as blade, the other with a chisel edge on which both burin-blow scars are distinct. In lower right corner a side-scraper made from a tortoise core and with the base (above the bulb of percussion of the flake) thinned by step-flaking. The two blades with rounded points are blunt-backed blades.

(Reduced to $\frac{1}{3}$.)

implement is 100 mm. long by 25 mm. broad (at its base), and has a back about 13 mm. high. The blunting flake did not run down the whole length of the blade, so that the back near the point has been blunted by the removal of a number of flakes, giving this part of the back the shape of a flat curve.

(*g*) *Giant Crescent.*—From the 26-foot level there is a very stout blade shaped like the segment of an orange. Its one face is a single flake surface, whilst the other is roughly flaked all over.

(*h*) *Burins.*—There are a number of artefacts apparently showing burin blows. Three implements are, however, undoubted burins; one is from the 20-foot level (not figured), whilst the other two (figured) are from near the base.

(*i*) Broad, flat blades, with prepared striking platforms, but with the fluting flakes divergent and with a flake surface cutting obliquely across the three fluting-flake scars. The largest one is figured and comes from the lower level. Another very similar one, but much smaller, is from the same level, whilst from the upper level there are three flakes of very coarse quartzite which are similar (as far as the coarseness of the medium would allow this) to the above.

The relative age of the Mossel Bay Industry has been established by Goodwin (S.A.J.S., vol. xxvii) as later than the Fauresmith and earlier than the Smithfield and the Wilton.

The remains of mammals found in the M.R., D. layer include bushbuck, duiker, ourebi, buffalo, aonyx, steenbuck, seal, dassie, bushpig, and warthog. The last named is the only one which is extinct (*Phacochoerus dreyeri*, Dreyer and Lyle). As to age, it therefore seems to agree with Leakey's *Kenyan monsterian*; to be perhaps more recent than the Still Bay of South Africa, of which Haughton states that a tooth of *Equus capensis* was found associated with it in the Fish Hoek Cave; and to be very much more recent than the flat triangular, slightly trimmed flakes from Floris Bad, which are associated with a number of extinct species.

As to the human remains, it seems to the writer that the Matjes River race is definitely less comparable to modern races than is Peer's Still Bay Man, and that the Mossel Bay Industry is therefore probably the more ancient of the two. The occurrence of *Equus capensis* at Fish Hoek cannot invalidate the evidence derived from the human material, since the Matjes River Cave had no horse remains, and it is quite uncertain when the giant Cape horse became extinct. Leakey's Aurignacian Man, more ancient than the Kenyan Still Bay, in the writer's opinion, shows a profile rather like that of Hottentot skulls from old graves, and therefore nearer to modern African races than the Matjes River race—again indicating a greater age for the Mossel Bay Industry than for the Still Bay.

RESUMÉ.

1. The succession in the Matjes River Shelter is M.R., E.—Mossel Bay Industry ; M.R., D.—less typical Mossel Bay ; M.R., C.—Wilton without pottery ; M.R., B.—Smithfield C. (?) ; M.R., A.—recent Bush.

2. Stone implements are comparatively rare, and if more were found it might have been possible to separate M.R., E. and M.R., D.

3. The animal remains are all of living species except for *Phacochoerus dreyeri* in M.R., D.

4. Burials are numerous down to about 20 feet (M.R., D.). Further down one burial was found at 26 feet and two at ±30 feet right on the rock floor.

5. The three lowest burials had the skulls embedded in *powdered* ochre. The M.R., D. skeletons (Matjes River race) had the skulls burnt, but *lumps* of ochre were placed near each skull. The M.R., C. (Wilton) burials—unlike all the others—were made in black loam ; no ochre, no cremation ; ostrich egg-shell container at each skull. The M.R., B. skulls were again covered with powdered ochre ; M.R., A. skulls no ochre, no burning.

6. To the writer the human remains and methods of burial seem to indicate two separate sets of immigrants—the Matjes River race, with their cremation rites ; and the Wilton people, with no particular treatment of the head. Sir Arthur Keith is of opinion that the immigrants are merely streams of local races of the Prehistoric S.A. race—a view the writer, particularly as regards the Wilton people, cannot agree with.

7. The writer is of opinion that the Matjes River race is older than the race represented by the Fish Hoek skull.

This paper is published with the financial assistance of the Carnegie Corporation and the Research Grant Board.

HERPETOLOGICAL NOTES AND RECORDS.—I.

By J. H. Power.

(With one Text-figure.)

This paper is mainly the record of a collection and field notes, made during a trip from Kimberley to Upington, and back, in January 1929. The ground covered was gone over rather hurriedly, not more than two days being spent at any one of the places touched.

The principal reasons for the excursion were to collect reptiles and amphibians with a view to ascertaining the limits of their westward distribution and to collect data concerning their habits.

As was to be expected in such a stretch of country, many surprises were encountered, especially in the matter of colour varieties of certain species.

The most important collection of the trip was made in the area between Kenhardt, Kakamas, and Upington. Campbell, Griquatown, Niekerk's Hope, and Koegas, though visited, are not mentioned here, as they will be dealt with in my account of the collections made in Griqualand West.

It has been thought desirable to include collections made by the author at Orange River Station and some specimens from Kleinzee, Namaqualand, collected by Mr. F. C. Wecke.

A sketch map of the country covered by this paper is added.

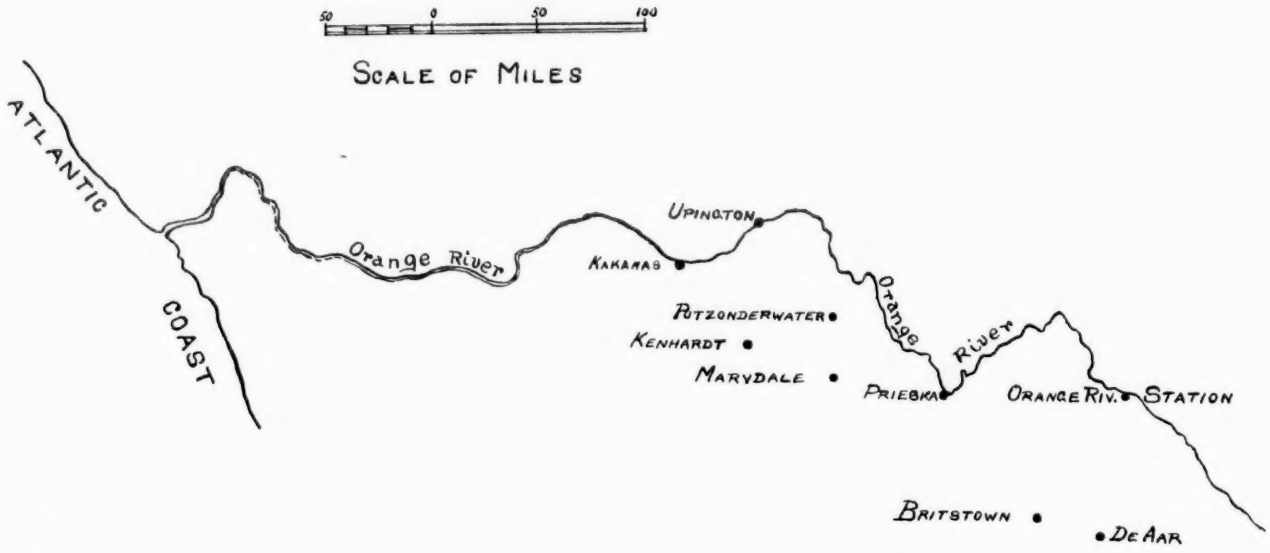
Annotated List of Species.

Testudinidae.

Testudo.

Testudo verreauxii, Smith, Ill. Zool. S. Afr., pl. viii, 1849.

This tortoise was collected at Orange River Station, Prieska, and Marydale. The females collected at Orange River Station show very little variation in general appearance, or in the markings and colour of the carapace; a dark brown or black, with broad yellow or reddish rays which vary in width and number, are the colours noted. The plastron, on the other hand, varies from a specimen with a few faint rays to one with a



PLACES WHERE COLLECTIONS WERE MADE.

complete absence of markings. Only two males were found here; these differ considerably in the colour of the rays and in general appearance. In one case the carapace is black with very distinct straw-coloured lines radiating from the centre of each shield. In the other the ground colour is also black, but the rays are much broader, dull yellow inclined to brown at the tips. This male, the smaller of the two, is not unlike those found at Britstown. The plastron in one case has distinct rays about the centre of the shield, in the other there are no distinct rays but the plastron is darkened at the centre.

The larger of these two males has only four neurals, the third and fourth being widely separated by the fourth costal on either side meeting on the vertebral line.

Only one young female was taken at Prieska on the north bank of the Orange River. This specimen resembles Smith's * figure of *T. verreauxii* in the colour of both carapace and plastron.

The Marydale specimens, six in all, four females and two males, form a series from a plastron with distinct rays to one without a trace of ventral pattern.

The colour and general appearance of the carapace of the females resembles that of the Orange River Station females, the rays ranging from a lemon yellow to a brick red. The usual type of colour-change brought on by age in tortoises is shown in one of these specimens—that is, a fading of the most contrasted elements of the colour pattern. This is mainly due to a lifting of the edges of the age-rings of the shields away from the shell.

The two males collected at this place differ somewhat in colour and markings, in one the areolæ are large and straw coloured, with rays of the same colour radiating therefrom; in the other the areolæ and rays are a dull yellow.

The proportions of the sexes differ considerably as the following table of averages shows:—

Averages.

Number Measured.	Length of Tail.	Width of Shell.	Length of Shell.†	Depth of Shell.
7 females . .	21·1 mm.	90·7 mm.	117·5 mm.	63·0 mm.
4 males . .	32·7 ,,	69·3 ,,	92·2 ,,	44·9 ,,

* Smith, A., *loc. cit.*

† The length was taken from the tip of the first marginal to the tip of the caudal shield.

In the males there is an absence of the usual concavity of the plastron.

The tail in both sexes is usually directed to the right when at rest.

The top of the head and the upper portions of the legs, as a rule, take the main colour of the carapace.

Testudo fiskii, Boul., Proc. Zool. Soc., p. 542, pl. lviii, 1886.

Three specimens collected at Britstown agree in every respect with Boulenger's description and figure of this species. They are all males, more or less the same size. Greatest length 96·0 mm., greatest width 72·0 mm.

The retention of this form as a regional variety seems justified, if only by the striking difference in habitus and size between it and the other specimens collected. The type of this species came from De Aar, which is close to Britstown.

Sufficient comparison material for the study of regional variation in the *verreauxii* sub-group is not yet at hand. When this is available it may be possible to divide those along the south side of the Orange River into topographic races. Even then a number of puzzling problems remain to be solved before the relations of the various forms can be expressed satisfactorily by means of a regional classification.

Testudo pardalis, Bell, Zool. Journ., iii, p. 420, 1828.

Three examples of this species were collected at Orange River Station. These do not differ in any particular from specimens found elsewhere.

Lacertilia.

Geckonidae.

Ptenopus garrulus, Smith, Ill. Rept. App., p. 6, 1849.

No specimens of this species were taken on the trip, but it was heard calling, just after sunset, at the following places: Orange River Station, Prieska, Marydale, Kenhardt, Kakamas, and Upington—in fact, everywhere touched.

Pachydactylus bibronii, Smith, Ill. Rept., pl. i, fig. 1, 1849.

This widely distributed species was found at Orange River Station, De Aar, Prieska, Kenhardt, and Upington, always under stones or in the clefts of rocks on the kopies. It was further noticed that this is a social species, several occupying the same crack or crevice in a rock, as many as twelve being taken from one cavity and fifteen from another.

No unusual colour difference was noticed.

Pachydactylus capensis, Smith, Ill. Rept., pl. ii, fig. 2, 1849.

This species was seen only at Orange River Station.

Pachydactylus latirostris, Hewitt, Ann. Nat. Mus., v, pt. 1, p. 69, 1923.

The type locality of this recently described species is Victoria West. One specimen was found under a stone, on the veld, not far from De Aar railway station. It agrees in every particular with the description of the type.

Agamidae.

Agama hispida aculeata, Dum. and Bibr., Erp. Gén., iv, p. 499, 1837.

This *Agama* was taken at Orange River Station, where it is fairly plentiful, De Aar, Prieska, Marydale, Kenhardt, and Upington. It was to be seen everywhere, sitting on the fence-posts; the colour and general appearance differs little even in widely separated localities.

Agama hispida brachyura, Boul., Cat. Liz., i, p. 350, 1885.

This form has been found at Kleinzee by Mr. F. C. Wecke.

Agama anchietae methueni, Boul. and Power, Trans. Roy. Soc. S. Afr., ix, p. 269, 1921.

The Hon. P. Methuen took this *Agama* originally in the Great Karas Mountains, Great Namaqualand. It apparently extends beyond the Orange River into the Cape Province, for it was quite common on stones along the roadside between Kenhardt and Kakamas, and also between Upington and Kenhardt. It is quite a distinct form, having characteristics of both the *atra* and *hispida* groups.

Agama atra, Daud., Hist. Rept., iii, p. 349, 1802.

Found everywhere. All the specimens collected resemble those to be found round Kimberley, in colour, form, and scutellation.

Zonuridae.

Zonurus polyzonus, Smith, Mag. Nat. Hist., (2) ii, p. 34, 1838.

This lizard was collected at Orange River Station, De Aar, Prieska, Kenhardt, and Upington. It is noteworthy that all the specimens taken at the last three places were a bright red ventrally, while those taken at De Aar were a very dark purple, almost black, ventrally. Those collected at Orange River Station were brick red speckled with very dark purple. Apparently all the members of this species in the districts of Britstown, Hanover, Philipstown, Colesberg, Middelburg, and Steyensburg belong to the dark variety. Round this area on the north and west is the red variety, while on the border-line between the two is a speckled variety.

Zonurus macropholis, Boul., Ann. S. Afr. Mus., v, pt. 9, p. 494, 1910.

Four specimens of this rare species have been sent from Kleinzee by Mr. F. C. Wecke.

Since Boulenger drew up his original description from only one specimen, it is thought advisable to give an amplified description here, based on the four specimens mentioned above.

No supranasal; head not depressed, as in *Z. cordylus jonesii*; nostril between a large nasal and a small postnasal. Head shields rugose; frontonasal broader than long, separated from the rostral by the nasals; nasals slightly swollen; praefrontals in contact with the inner angle of the large nasal (in one case it was in contact on the one side and not on the other); frontal hexagonal, much longer than broad, narrowed posteriorly; frontoparietals about as long as broad; interparietals, between two pairs of parietals, may or may not be in contact with the frontoparietals; pineal foramen distinct; anterior parietals larger than the posterior ones; occipital scaling not differentiated from that of the dorsal surface of the body; temporals very strongly keeled; four supraoculars, the second from the front the largest; three or four supraciliaries; loreal large, may or may not be in contact with the nasal, postnasal, or frontonasal; two suboculars; rostral $2\frac{1}{2}$ to $2\frac{3}{4}$ times as broad as deep; four or five upper labials; five lower labials, 3rd, 4th, and 5th keeled, bordered below by four or five large shields, the 3rd or 4th posterior ones strongly tricarinate; chin shields small and irregular, keeled; gular scales large, imbricate, strongly keeled and strongly mucronate; sides of the neck with regular erect spines. Dorsal scales large, forming regular transverse series, very strongly keeled, and mucronate throughout, making longitudinal spinose ridges; 16 to 18 transverse series (from occiput to base of tail) of scales, 14 large scales round the centre of the body dorsally, a distinct lateral fold. Ventrals quadrangular, in 9 or 10 longitudinal series, strongly keeled and mucronate, excepting the 2 or 4 central series. A pair of feebly enlarged preanal plates, with smaller ones in front and at the sides. Limbs above with large, keeled, spinose scales; 4 or 5 femoral fleshy glandular tubercles, with 6 pores beneath, on either side. Tail with 18 to 20 whorls of large, elongated, spinose, strongly keeled scales, lower caudals smaller, not so strongly mucronate or carinate as the upper ones.

Colour.—The upper parts of the head almost uniform dark brown; below the eyes and under the chin greyish; the dorsal surface of the body grey with irregular dark brown blotches; the ventral surface uniform greyish; tail grey above, pale grey below.

Measurements of three specimens from Kleinzee:

Total length . .	114	120	104 mm.
Length of head .	16	16	16 „
Width of head . .	13	13	13 „
Body . . .	60	64	51 „
Fore limb. . .	21	22	23 „
Hind limb . .	30	30	26 „
Tail . . .	54	56	53 „

Lacertidae.

Eremias namaquensis, Dum. and Bibr., Erp. Gén., v, p. 307, 1839.

This species seems to be widely distributed to the west. It was taken at Putzonderwater, Prieska, Britstown, De Aar, and Orange River Station.

Eremias undata, Smith, Mag. Nat. Hist., ii, p. 42, 1838.

One specimen taken at Prieska is referable to this species. It agrees with the colour variety named *inornata* by Roux.* In this specimen the supraoculars are separated from the frontal by granules.

Boulenger † anticipates that in the future a series will be available, linking up this form with *namaquensis*. It is, however, significant that although the latter was also found at Prieska, no intermediates, in the condition of the lower eyelid, were found.

Eremias lineo-ocellata, Dum. and Bibr., Erp. Gén., v, p. 314, 1839.

This species was collected at De Aar and Orange River Station. The colour and markings of examples from the above places does not differ materially from Kimberley specimens.

Scincidae.

Mabuia occidentalis, Peters, Mon. Berl. Ac., p. 20, 1867.

Taken at Kenhardt, Marydale, Prieska, and De Aar. In all these specimens there are two or three projecting auricular lobes.

This differentiation in the scales on the anterior border of the ear does not seem to me a sufficient reason for separating this form from *M. trivittata*, as I shall point out in a future paper on the Griqualand West collections.

It was noticed that this species had its burrow usually at the foot of a bush or small tree, into which it climbed. It dropped to the ground quickly on the approach of anyone.

Mabuia trivittata, Cuv., R. An., 2nd ed., ii, p. 62, 1817.

This species was found at Prieska, De Aar, and Orange River.

Mabuia sulcata, Peters, Mon. Berl. Ac., p. 20, 1867.

Several specimens of this species were collected at Kakamas, Kenhardt, Prieska, and De Aar.

It is of great interest to find a distinct colour variety of this form inhabiting the area around and between Kenhardt and Kakamas. Furthermore, the interest is increased by the fact that the colour is in harmony with that of the rocks on the kopies inhabited by it. The colour is a uniform brownish olive above in both sexes, the females being, as usual,

* Roux, Zool. Jahrb., Syst., xx, p. 427, 1907.

† Boulenger, Mon. Lacert., p. 286, 1921.

striped; both sexes are white beneath, the chest and throat of the male being a brick red; this same part is speckled with black in the female.

The males of this species are jet black in the Kimberley neighbourhood, in harmony with the boulders of karroo dolerite which weather black.

Mabuia striata, Peters, Mon. Berl. Ac., p. 36, 1844.

This species seems to be widely distributed along the banks of the Orange River; it was found at Upington, Kakamas, Kenhardt, Marydale, Prieska, and Orange River Station.

In most cases the specimens collected were shot from the branches of large Acacia trees (*Acacia karroo*). The black dorsal colour and dull lateral stripes harmonise so well with the dark bark of the trees that they are by no means easy to see. At Marydale it was found on the ground, under tins, stones, and small Mesembryanthemum bushes, on the outskirts of the village. At Prieska it is very common along the banks of the Orange River, being always found in the tall *Acacia karroo*. Sometimes they were seen on the trunks of these trees close to the ground; should anyone approach, they immediately glide round to the opposite side and hasten towards the top of the tree.

The wonderful adaptability of this lizard is no doubt responsible for its wide distribution, for it seems to be able to suit itself to any situation. At Marydale, not far from Prieska, where trees are scarce, it lives on the ground and seems to thrive there.

The stomachs of the specimens collected contained ants, beetles, larvae of Lepidoptera, plant seeds, cicadas, locusts.

Mabuia varia, Peters, Mon. Berl. Ac., p. 20, 1867.

This is also a widely distributed species; one specimen was taken on the kopies to the west of De Aar Station. It does not differ in colour or markings from specimens collected at Linokana, West Transvaal. Contrary to its name, it seems to have a comparatively small range of variability.

Scelotes bipes, Linn. S.N., i, p. 390.

One example of this form has been received from Kleinzee, Namaqualand.

Chamaeleontidae.

Lophosaura ventralis, Gray, Cat. Liz., p. 268, 1845.

One specimen from Kleinzee resembles in every respect this species.

Batrachia.

Ranidae.

Rana fuscigula, Dum. and Bibr., Erp. Gén., viii, p. 386, 1839.

This species was found at Orange River Station, Prieska, Marydale,

Britstown, and De Aar. It is very plentiful at all these places, inhabiting every permanent stream or dam. At Marydale some particularly large examples were collected, one of these measured 126 mm. from snout to vent.

The specimens collected at Orange River Station were found in a small permanent pool of very brackish water. This water was analysed for me by the late Mr. John Parry, De Beers chief chemist, with the following results:—

$CaCO_3$, 7·0; Na_2CO_3, 53·53; Na_2SO_4, 34·32; NaCl, 61·15. Total solids, 156·0 parts per 100,000.

Rana delalandii, Dum. and Bibr., Erp. Gén., viii, p. 388, 1839.

Considering that *R. fuscigula* is so common at other places along the Orange River, I was somewhat surprised to find this species at Upington. Several specimens were taken in pools of rain-water about half a mile away from the river. It was found at no other place during the trip.

Pyxicephalus delalandii, Tsch., Class Batr., ii, p. 84.

This species is plentiful in the furrows of the lucerne lands at Kakamas and in pools of rain-water at Upington. Being a burrowing form, it is rarely found except after rain; as we did not encounter rain during the expedition we probably missed it at several places.

Phrynobatrachus natalensis, Smith, Ill. Zool. Rept., App., p. 23, 1849.

Four examples were collected at Upington in a pool of rain-water. The characteristic call could be heard at quite a distance from this pool.

Cacosternum boettgeri, Boul., Cat. Batr. Sal., p. 118, 1882.

This little frog was found at Prieska, Orange River Station, and De Aar. Its call is exactly the same wherever it has been taken.

Engystomatidae.

Breviceps namaquensis, Power, Ann. S. Afr. Mus., xx, p. 465, 1926.

One specimen from Kleinzee is recognised as belonging to this species.

Bufonidae.

Bufo gariepensis, Smith, Ann. Mag. Nat. Hist., xii, p. 215, and Ill. Zool. S. Afr., iii, pl. lxix, figs. 2 and 3, 1849.

This toad is common all along the Orange River. It was found at every place visited during the trip: Orange River Station, Prieska, De Aar, Britstown, Marydale, Kenhardt, Kakamas, and Upington.

Bufo regularis gutturalis, Power, Trans. Roy. Soc. S. Afr., xiv, p. 416, 1927.

This form was found calling at Upington, in a pool of rain-water half a mile from the river. Evidently it is more widely distributed than it was at first thought to be.

Bufo vertebralis, Smith, Ill. Zool. Rept., pl. lxviii, fig. 2, 1849.

Three specimens were collected at Orange River Station. They were found breeding in a pool of rain-water.

A REVISION OF THE GENUS *LOPHOLAENA* DC.

By E. P. Phillips, M.A., D.Sc., and C. A. Smith, B.Sc.

As originally established by De Candolle in 1837 (Prodr. vi. 335) on *L. dregeana* DC., of which the type specimens had been collected by Drège some time before in Pondoland, the genus remained monotypic until 1872, when, as Spencer Moore points out (Journ. Bot. lxvii. 274 : 1929), "Bentham, notwithstanding the absence of a dorsal plate from its involucral leaves, with rare sagacity described and figured (Hook. Ic. Pl. xii. 12, t. 1113) a second species—*L. platyphylla*—from specimens collected by Gerrard and McKen in Natal about 1865." These specimens were further characterised by the presence of three large foliaceous "peduncular" bracteoles which quite enfold the capitula, and were on that account, perhaps erroneously, described by Bentham as "bracteae exteriores" (the involucre being strictly uniseriate).

It was, however, not until 1903 that a third species was definitely referred to the genus, when Spencer Moore described (Journ. Bot. xli. 133) *L. randii* from specimens collected by Dr. R. F. Rand in September of the previous year on the kopjies round Johannesburg. The same species had already been collected in 1842 by Burke and Zeyher on the Magaliesberg near Pretoria, but was described (Fl. Cap. iii. 315 : 1864–65) as a doubtful species of *Othonna*—*O.*? *coriifolia* Sond. In this Sonder, from whom Harvey had taken up the description, was probably misled by the absence of the median longitudinal dorsal crest or "wing" on the involucral scales, which at once characterises the type of the generic name (and from the presence of which the latter is derived), as well as by the fact that the type material (of Sonder's species) was in the young-bud stage of floral development, during which period the resemblance of the capitula to those of an *Othonna* is most marked. This then was the first authentic record for the genus in the Transvaal.

The next additions were again made by Moore, who was probably the first to recognise the distinctive character of the deeply cleft style with its flattish, linear, subobtuse branches, hairy on the outer face and papillose on the inner, which thus readily serves to distinguish the genus from *Senecio* and *Othonna*, while from *Hertia* Neck. (=*Othonnopsis* Jaub. and

Spach) it differs in the absence of fertile female marginal florets. In recognising the very valuable differences in the style branches, Moore was led to transfer four species from *Othonna* (including *Doria* Auct. nonnull., non Thunb.) and *Senecio* to *Lopholaena* as *L. disticha* (=*O. disticha* N. E. Br.), *L. cneorifolia* (=*D. cneorifolia* DC.), *L. segmentata* (=*S. segmentata* Oliv.), and *L. dolichopappa* (=*S. dolichopappa* O. Hoffm.), these new combinations being published in the first and preliminary key to the then known species of the genus (Bull. Herb. Boiss. sér. 2. iv. 1021 : 1904). Curiously enough, Moore overlooked *S. ussanguensis* O. Hoffm. (Engl. Bot. Jahrb. xxx. 438 : 1901), this being, however, transferred by Moore in a later paper (Journ. Bot. lxvii. 274 : 1929). In this later paper four species were added to the genus (which then stood accredited with eleven species), two of these, *L. phyllodes* (=*Vernonia phyllodes* Hiern.), *L. ussanguensis* (O. Hoffm.), being new combinations effected on the strength of their style characters, a third—*L. brickellioides*—having already been described under the genus in 1911 (Journ. Linn. Soc. xi. 118), and the fourth, "*L. bainesii*" (=*L. glaucescens* Nob.), a new species based on a Welwitsch plant, but confused by Moore with *Othonna bainesii* O. and H. Some time prior to the last paper on the genus, three other species had in two different publications been referred to the genus as first emended by Moore in 1904, although not dealt with by the latter in his 1929 paper. These are *L. acutifolia* R. E. Fries, *L. pauciflora* Thell., and *L. longipes* (DC.) Thell. (=*Doria longipes* DC.), and inclusion of the two latter in the genus, along with *L. dolichopappa* (O. Hoffm.), *L. whyteana* (Britt.), definitely introduces two important characters not previously met within the genus. Thus, of the last four species each possesses a pappus which elongates in the fruiting stages of the capitula to one and a half times the length of the involucre, and peduncles (terminal or axillary) aggregated towards the apices of the branches and exceeding the leaves by as much as three times. Such characters are of interest in that they are associated with few-flowered solitary capitula, the involucre of which splits into its component segments during the fruiting stage, and mark an obvious evolutionary stage in further perfecting the means for dispersal of the fruit.

The affinities of the genus *Lopholaena* DC. appear to be with *Othonnopsis* Jaub. and Spach, and in an attempt to establish these it was soon found (as is frequently the case with genera of *Compositae*) that an extended investigation into the limits and nomenclature of the latter genus would first have to be undertaken. This gave the following results: O. Kuntze had already (Rev. Gen. i. 344 : 1891) contended that *Othonnopsis* Jaub. and Spach (1852) was synonymous with *Hertia* Neck. (1790), and had published (*loc. cit.*) new combinations for several species of *Othonnopsis* under *Hertia*. In this he followed Bentham's tentative suggestion (Benth.

and Hook. f. Gen. Pl. ii. 453 : 1873) that "*Hertia* Neck. Elem. i. 8, est verisimiliter ipsa *O.*[*thonna*] *cheirifolia*," which Bentham cites under *Othonnopsis* Jaub. and Spach (Ill. Pl. Or. iv. 90 : 1850–53).

Unfortunately Necker cites no specimen, figure, or species for his type, but from his description, deficient as this is in critical details, there seems to be no reason for not regarding *Othonnopsis* Jaub. and Spach as congeneric with *Hertia* Neck. Curiously enough, although aware of Necker's generic name and description, Lessing (Linnaea, vi. 94 : 1831, and Syn. Pl. 88 : 1832) also established a genus *Hertia*, which he based upon "*Othonna crassifolia* Linn." As to Lessing's interpretation of the latter species, however, there appears to be some doubt, since it is highly improbable that Lessing ever saw a specimen of the "true" *Othonna crassifolia* Linn., which is so far known only from two coloured plates cited by Linnaeus. (See note below. There are no specimens of the species either in Herb. Cliff. or Herb. Linn., and there appears to be no evidence to show that Linnaeus himself ever saw a specimen.) Nor does it seem likely that a careful synantherologist such as Lessing would fail to recognise a true *Othonna*. On the other hand, *Othonna cheirifolia* Linn. [i.e. *Hertia cheirifolia* (Linn.) O. Kuntze] had long been in cultivation in European gardens as *Othonna crassifolia*, and still known as such during the period of Lessing's activity, and it seems more than probable that Lessing based his genus *Hertia* on this species (i.e. *Othonna crassifolia* Hort. non Linn.). *Hertia* Less. is thus the same as *Hertia* Neck.

The following note explains the position with regard to *Othonna crassifolia* Linn. and *O. cheirifolia* Linn., which have frequently been wrongly interpreted:—

Linnaeus established *O. cheirifolia* in his Sp. Pl. ii. 926 (1753), with two groups of synonyms, and under α (without the symbol) he cited *Othonna foliis lanceolatis integerrimis* Hort. Cliff. 419; Royen Lugdb. 179; and *Jacobea africana frutescens crassis* and *succulentis foliis* Comm. hort. 2, 147. t. 74; Ray Suppl. 174. Under the second (or β) group he cited *Aster fruticosus africanus luteus, foliis Thymeleae*, Raj. Suppl. 161 (sphalm., 167), and gave the habitat as "in Aethiopia." It should not, however, be considered that α was necessarily the type of Linnaeus' species rather than β. See, for example, Sprague in Rhodora, xxx. 55 (1928).

Later, in his Sp. Pl. Ed. 2. ii. 1310 (1763), Linnaeus merged the two groups of synonyms into one, omitting the symbol β. He also introduced two additional references, "Duham. arb. 2. p. 94. t. 17," and "Gouan. monsp. 464," and dropped the Commelin and the first Ray citations. Then, in his Mantissa, 118 (1767), he separated the first element of his *O. cheirifolia* (1753) as a new species, *O. crassifolia* Linn., with the following synonymy:—

Othonna foliis lanceolatis integerrimis, caule erecto, Hort. Cliff. 419; Roy. lugdb. 179; Mill., Ic. 163. t. 245, f. 2.

Jacobea africana frutescens, foliis crassis, and *succulentis foliis,* Comm. hort. 2, 147. t. 74; Raj. Suppl. 174, adding "*Habitat ad* Cap. b. Spei —Similis *O. cheirifoliae, sed erecta, quadripedalis.*" From this it is clear that Linnaeus' conception of *O. cheirifolia* underwent considerable modification, and it might be supposed that he intended that the name of the species should be restricted to Ray's *Aster fruticosus africanus luteus foliis Thymeleae* (Suppl. 161, n. 42).

The actual type, however, is the specimen in Herb. Linn., which, according to Jackson's Index, must have been in Linnaeus' possession before 1753. This conclusion is confirmed by data given below. The specimen was written up as *O. cheirifolia* by Linnaeus himself, and the sheet on which it is mounted is endorsed on the back in his hand as follows: "*Calthoides fol. oblongis copiis crassis* Shaw afr. 103, *ex semina* D. Shaw *ennata Milleri.*" Now this specimen is a perfect match of the plant figured by Miller, Ic. ii. 163. t. 245, f. 1, as *Othonna foliis cuneiformibus integerrimis sessilibus, caule fruticosa procumbente pedunculis longissimis,* and of which Miller notes (*loc. cit.,* 273): "The seeds of this sort were brought to *England* by the late Dr. Shaw, who discovered the Plants growing naturally at Algiers." The specimen in Herb. Linn. was probably obtained by Linnaeus from Miller's type plant in the Chelsea Physic Garden in 1736, when he paid his memorable visit to England. Thus he says in his diary for the period: "Miller of Chelsea permitted me to collect many plants in the Garden . . .," which also explains the information (obtained from Miller) written on the back of the sheet in his herbarium.

The strange part of this is that Linnaeus appears never to have mentioned the specimen in any publication, except perhaps by inference when, in the Syst. Nat. Ed. 12, 579 (1767), he cites Miller's plate for the first time in finally defining his *O. cheirifolia* as follows:—

"*O. fol. lanceolatis trinerviis integerrimis, caul. suffruticoso repente. (Excluso Synonymo Hort. Cliff.) Mill. Ic.* 245. *f.* 1." From the foregoing it is thus clear that the specimen in Herb. Linn. may be regarded as the type of *Othonnopsis cheirifolia* (Linn.), i.e. *Hertia cheirifolia* (Linn.) O. Kuntze.

On historic as well as taxonomic grounds this species can be accepted as the type of the generic names *Othonnopsis* and *Hertia.*

Interpreted as above, *Hertia* Neck. approaches very close to *Lopholaena* DC., though the differences are far more marked between these two genera than is the case between *Hertia* Neck. and *Othonna* Linn., and it is of interest to note how closely such species as *H. cluytiifolia* (DC.) O. Kuntze and *H. pallens* (DC.) O. Kuntze resemble, for example, *L. cneorifolia* (DC.)

S. Moore in general external characters, similar leaf-types and growth forms being developed in all three. Other species of *Lopholaena* again, such as *L. disticha* (N. E. Br.) S. Moore and *L. platyphylla* Benth., agree more nearly with some species of *Othonna* in their broadly expanded fleshy leaves (cf. *O. amplexicaulis* Thunb.), and in the fleshy dorsal face of the involucral bracts, the habit of *L. platyphylla* Benth. also agreeing with that of the species of *Othonna* cited. A third group again, including *L. dolichopappa* (O. Hoffm.) S. Moore and *L. whyteana* (Britt.), agrees with some species of *Doria* in the development of elongating peduncles and pappi in the fruiting capitula.

From *Hertia*, however, *Lopholaena* is readily distinguished by the characters of its style-branches, well described by Bentham (Gen. Pl. ii. 441) as "subcomplanati, in appendices longas, lineares, dorso hirtellas desinentes," apart from the heads being consistently discoid, the same character of the style-branches serving also to distinguish *Lopholaena* from *Othonna*.

As circumscribed in the present paper, the generic description embraces several characters which appear to lend themselves readily towards division of the species into well-marked groups. Moore had already in his 1929 paper proposed the division of the genus into three groups on the nature of the involucral bracts, and for these groups he proposed the names:

1. *Platylopha :* Appendage to involucral leaf an erect lamina.
2. *Pachylopha :* Involucral appendage cushion-like.
3. *Alopha :* No involucral appendage (present).

The writers, however, incline towards utilising the disposition of the capitula on the branches for the primary divisions. Thus:

Section 1: PANICULATAE, Nob.—Heads disposed in a lax, open bracteate panicle, never surrounded by the upper foliage leaves.

L. segmentata (Oliv.) S. Moore and *L. brickellioides* S. Moore (the only two species).

Section 2: SIMPLICES, Nob.—Heads never disposed in an open paniculate inflorescence, usually solitary, axillary, or terminating abbreviated shoots, or aggregated at the ends of the branches and more or less surrounded by the upper foliage leaves.

A consideration of the habit of the species involved allows this second section to be divided into two very well-marked subsections:

Fruticosae, subsect. nov.—Perennial shrubs or suffrutices (with a single main stem). Rootstock not woody-tuberous and thickened.

e.g. *L. cneorifolia* (DC.) S. Moore, *L. coriifolia* (Sond.) Nob., etc.

Multicaules, subsect. nov.—Stems several from the same more or less thickened woody-tuberous rootstock, arising separately and dying down each year.

Then by utilising the character of the involucral bracts, as suggested by Moore, the subsect. *Multicaules* can be further subdivided, with the modification of including the group *Pachylopha* under *Alopha*. Thus:

Platylophae (S. Moore) Nob., series nov.—Involucral bracts with a distinct median longitudinal expanded crest or lamina.

L. dregeana DC. (the only species).

Alophae (S. Moore emend.), Nob., incl. § *Pachylopha* S. Moore. Involucral bracts devoid of a median dorsal crest or lamina.

L. disticha (N. E. Br.) S. Moore, *L. platyphylla* Benth., etc.

We have to thank the Curators of the various South African herbaria for sending us the material in their respective collections for examination, as well as the Directors and Keepers of the European herbaria mentioned in the list further on for facilities to examine many types and additional material.

In order to facilitate reference to authenticated and type specimens an abbreviation of each of the herbaria, in (or from) which specimens have been examined, has been inserted after each specimen cited. The following will explain each of the abbreviations adopted:

AM = Herbarium of the Albany Museum, Grahamstown, C.P.
B = Bolus Herbarium, Kirstenbosch, Newlands, C.P.
Be = Herbarium of the Botanical Museum and Gardens, Berlin-Dahlem.
BM = Herbarium of the British Museum (Natural History), South Kensington, London.
Gc = Herbarium de Candolle, Herbarium Delessert, Conservatoire Botanique, Geneva.
HM = Herbarium of the late Professor C. E. Moss at the Witwatersrand University, Johannesburg.
K = Herbarium of the Royal Botanic Gardens, Kew, Surrey.
M = Herbarium of the McGregor Museum, Kimberley, C.P.
Na = Natal Herbarium, Durban, Natal.
Pa = National Herbarium, Pretoria, Transvaal.
SM = Herbarium of the South African Museum, Cape Town.
TM = Herbarium of the Transvaal Museum, Pretoria, Transvaal.
U = Herbarium of the University, Uppsala, Sweden.

Lopholaena DC., Prodr. vi. 335 (1837); Endl., Gen. Pl., 458, n. 2808 (1838); DC. in Deless. Ic. Sel. Pl. iv. 26 (1839); Meisn. Pl. Vasc. Gen. i. 214 (1839); Spach, Hist. Végét. x. 32 (1841); Harv. in Harv. and Sond. Fl. Cap. iii. 314 (1864–65), and Gen. S. Afr. Pl. ed. 2, 197 (1868); Benth. and Hook. f. Gen. Pl. ii. 441 (1873); Baill. Hist. Pl. viii. 266 (1882); O. Hoffm. in Engl. and Prantl, Nat. Pflanzenfam. iv. 5, 294 (1892); S. Moore in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904), emend.; Thonn. Blütenpfl. Afr. 608 (1908), and Flow. Pl. Afr. 575 (1915); Phill. Gen. S. Afr. Pl. 670 (1926); S. Moore in Journ. Bot. lxvii. 274 (1929), emend.

Hemicryptophytes, with several stems arising separately from a more or less thickened woody-tuberous rootstock, or bushily branched small (rarely tall) shrubs. *Leaves* distichous or scattered, sessile or subsessile, variously shaped, from narrowly linear to suborbicular, frequently very large, often broadly amplexicaul and decurrent on to the

stems, branches or branchlets as a distinct, frequently broad, entire wing, entire margined, 1–7-nerved from the base upwards, fleshy-herbaceous to fleshy-coriaceous, rarely with a distinct indumentum, frequently glaucous. *Heads* discoid, few- to many-flowered, disposed in a lax, open, bracteate panicle, or single and terminal, or (and) axillary on much abbreviated shoots, or aggregated in clusters at the apices of the branches and surrounded by the upper foliage leaves, sometimes associated with 2–3 large enveloping foliaceous bracteoles which are often long-decurrent along the supporting shoot. *Involucre* uniseriate, sometimes surrounded by several whorls of much-reduced foliage leaves and thus appearing pluriseriate, almost invariably glabrous; scales few to many, frequently connate for about two-thirds of their length, at length free to the base, flat, or concave within and convexly keeled without, more rarely with a wide median longitudinal crest or "wing," with broad membranous margins. *Receptacle* flat and honeycombed, with the margins of the alveoli slightly raised. *Florets* bisexual, white to purple in colour; the innermost (always?) sterile. *Corolla* cylindric but widening in the upper third into a campanulate 5-toothed exserted limb, very generally articulated at about the middle of the cylindric part, quite glabrous; teeth deltoid to ovate-deltoid, subacute. *Anthers* linear, tipped with an ovate to ovate-oblong subacute appendage, blunt (never saggitate) and ecaudate at the base. *Filaments* more or less swollen just below the anther bases, glabrous. *Ovary* ovoid or oblong in outline, glabrous to densely white villous. *Style-branches* spreading-recurved when ripe, linear, tapering to the obtuse apex, flattened and papillose on the upper face, densely hairy along the outer convex surface. *Achenes* usually obscurely ribbed, glabrous to densely silky-villous. *Pappus-bristles* copious, 2–3-seriate, slender, microscopically barbellate, often much elongated in the fruiting stages, white to straw-coloured.

Key to the Species.

Inflorescence a loose panicle:

Leaves sessile, broadly amplexicaul, the lower markedly decurrent as a stem-wing, 1. *L. segmentata.*

Leaves (at least the lower) distinctly petioled; stem-wings absent, 2. *L. brickellioides.*

Inflorescence never as above: heads solitary or 2–3 together (subracemose):

Heads always associated with 2–3 large enveloping foliaceous bracts which are usually also long-decurrent on the peduncle: leaves always distinctly decurrent on the stem:

Leaves distichous:

Leaves suborbicular, up to 7 cm. long and 9 cm. wide, broadly- and long-decurrent on the stem . . . . . 3. *L. decurrens.*

Leaves elliptic or oblong-elliptic, up to 4 cm. long and 3·5 cm. wide, very narrowly and shortly decurrent on the stem . . 4. *L. disticha.*

Leaves scattered . . . . . 5. *L. platyphylla.*

Heads never associated with 2–3 large foliaceous enveloping bracts, though sometimes with many surrounding much-reduced bracteal leaves similar to the involucral scales: leaves seldom decurrent along the stems:

Involucral bracts with a broad dorsal erect median "wing" or crest, 6. *L. dregeana.*

Involucral bracts never as above, at most only with a very slight obsolete median ridge:

Leaves prominently 3–5-nerved from the base upwards:

Involucral bracts (at least the outer) white cottony-hairy on the dorsal face, 7. *L. phyllodes.*

Involucral bracts always glabrous:
Leaves decurrent at the base as a stem-wing:
Leaves lanceolate, acute, up to 10 cm. long and 2 cm. wide: heads with reduced bracteal leaves surrounding the involucre, 8. *L. acutifolia.*
Leaves broadly oblong-elliptic to suborbicular, obtuse or rounded at the apices, up to 6 cm. long and 5 cm. wide: heads without reduced bracteal leaves round the involucre, 9. *L. ussanguensis.*
Leaves never manifestly decurrent on the stems:
Leaves elliptic and markedly tapering to an acute apex: nerves at first subparallel, eventually converging towards the apex of the leaf . . . . . 10. *L. bainesii.*
Leaves obovate, always rounded at the apex: nerves diverging from the base up . . . . . 11. *L. coriifolia.*
Leaves prominently 1-nerved (never more) from the base upwards:
Peduncles usually much shorter than (rarely subequalling) the leaves surrounding them, and without subulate bracteoles:
Capitula each terminating a short axillary or terminal leafy branchlet, 13. *L. brevipes.*
Capitula aggregated in clusters at the apices of the branches, 12. *L. cneorifolia.*
Peduncles always much exceeding the leaves subtending them, usually with one or two subulate bracteoles:
Leaves not decurrent on the branchlets: heads 5–6-flowered:
Plants with many stems from the same rootstock:
Leaves obovate-spathulate to obovate, up to 6 cm. long and 1·5 cm. wide . . . . . 14. *L. whyteana.*
Leaves narrowly linear to narrowly linear-oblanceolate, up to 4 cm. long and 1·5 mm. wide . 15. *L. dolichopappa.*
Plants bushily branched shrubs, with a single main stem: leaves obovate-oblanceolate, up to 3·8 cm. long and 6 mm. wide, 17. *L. longipes.*
Leaves narrowly decurrent on the branchlets, frequently with woolly axillary tufts: heads 3–4-flowered . . . 16. *L. pauciflora.*

1. **L. segmentata** (Oliv.) S. Moore in Bull. Herb. Boiss., sér. 2. iv. 1021 (1904); and in Journ. Bot. lxvii. 275 (1929).

Senecio segmentatus Oljv. in Hook., Ic. Pl. ser. 3. v. 65, t. 1483 (1885); O. Kuntze, Rev. Gen. III. ii. 177 (1898).

A hemicryptophyte. *Rootstock* much thickened and somewhat ligneous with age. *Stems* usually several from the same rootstock, unbranched, leafy for the greater part, up to 50 cm. high, ascending-erect or erect, striate, glabrous. *Leaves* decussate, obovate-elliptic to suborbicular, rounded at the apex and slightly narrowing towards the sessile amplexicaul base, up to 4 cm. long and as much wide (the upper gradually smaller), subcarnose and glaucescent, glabrous, with cartilaginous margins; the lower leaves decurrent on the stem in the form of a definite stem-wing, though only shortly so. *Inflorescence* a lax, many-headed, leafless terminal more or less flat-topped panicle, often up to 25 cm. in diameter, glabrous in all parts. *Heads* 5–6-flowered. *Involucre* 1-seriate, up to 1·7 cm. long; bracts usually 5, oblong to linear-lanceolate, subacuminate, concave within and convex without, occasionally flat, ecarinate or obsoletely keeled in the upper-

most quarter only. *Receptacle* flat, more or less shallowly pitted. *Ovary* glabrous. *Pappus* up to 9 mm. long.

NATAL.—Durban Div.: Slopes of Field's Hill, near Durban, 360 m., Jan., *Wood in Natal Herb.* 704! Type (BM, K), and *eod. loc.*, 300 m., Feb., *Wood* 1925! (BM, K). Pietermaritzburg Div.: Krantzkloof, 550 m., March, *O. Kuntze*! sine num. (K). Vryheid Div.: On the Emyati Mountains, along grassy slopes of Leeuw Nek, Feb., *Thode in Natal Herb.* 16343! (K).

SWAZIELAND.—Open veld "near Miller's house," Jan., *Burtt Davy* 2809! (BM).

TRANSVAAL.—Barberton Div.: At or near Barberton, Jan., *Thorncroft in Herb. Trans. Mus.* 3962! (TM). Lydenburg Div.: On the farm "Zwagershoek," near Lydenburg, Jan., *Obermeyer* 291! (TM); stony places near Lydenburg, Nov., *Wilms* 797! (BM, K), and *eod. loc.*, Jan., *Wilms in Herb. Trans. Mus.* 10770! (TM). Ermelo Div.: Spitskop, near Ermelo, 1800 m., Dec., *Mrs. Potts* 5017! (B, K, TM). Middelburg Div.: "Pokwani," *Rogers* 24840! (TM); on the farm "Uitkyk 36," April, *Pole Evans* H. 11637!; Elandspruit Kop, 1900 m., Dec., *Schlechter* 3881! (B).

2. **L. brickellioides** S. Moore in Journ. Linn. Soc., xi, 118 (1911); and in Journ. Bot. lxvii. 275 (1929).

A large shrub or small tree, up to 3 (or more?) m. high, glabrous in all parts. *Stems* moderately stout at the base, becoming more or less laxly branched higher up. *Branchlets* ascending-erect, laxly leafy towards the apices, terete, striate. *Leaves* obovate- to elliptic-oblong, scattered, up to 8 cm. long and 5 cm. wide, rounded at the apices, somewhat thick in texture, conspicuously 1-nerved; the lower gradually tapering into a petiole up to 3·5 cm. long; the upper sessile on a rounded or subtruncate base, becoming much reduced upwards. *Inflorescence* a lax many-headed rounded panicle up to 20 cm. long and 15 cm. wide, with the bracteal leaves more or less similar to the cauline but much smaller (up to 2·5 cm. long), eventually becoming greatly reduced. *Heads* campanulate-cylindric, usually 7-flowered. *Involucre* uniseriate, up to 1 cm. long; bracts about 5, oblong-linear, flat, ecarinate, acute. *Achenes* obscurely 5-gonous, sericeous-hirtellous.

SOUTH TROPICAL AFRICA.—Rhodesia: Gazaland, Chimanimani Mountains, 2100 m., Sept., *Swynnerton* 1802! Type (BM, K); Mount Pene or Singwekwe, 2100 m., Oct., *Swynnerton* 6133! (BM, K). Inyanga, on forest margins, Aug., *Henkel in Herb. Eyles* 2560! (K).

This species is one of the most distinct in the genus and, but for its uniseriate involucre, might be readily mistaken for a species of *Vernonia*, further resembling members of this genus in the purple florets. It approaches nearest to *L. platyphylla* Benth. in its tall habit, but differs from this in almost all the other characters, while in its panicled inflorescence it comes near to *L. segmentata* (Oliv.) S. Moore, though leaf-characters readily separate the two species, apart from the differences in habit.

3. **L. decurrens** (Hutch.) Phill. and C. A. Sm., comb. nov.

Othonna decurrens Hutchinson in Kew Bull. 1907, 50; and in Gard. Chron., ser. 3. lvi. 28, f. 13 (1914).

Rootstock not seen, but very probably a much enlarged and ligneous underground tuber. *Stems* erect or ascending-erect, simple, closely leafy, striate, glabrous. *Leaves* distichous, sessile, suborbicular, long-decurrent at the base in a wide-spreading stem-wing, up to 7·5 cm. long and 9 cm. in width, suberect and somewhat adpressed to the stem, palmately 8-nerved, with the nerves more or less prominent on both surfaces, somewhat fleshy, glabrous, and glaucescent. *Heads* campanulate, solitary, axillary, or terminal, long-peduncled, enfolded by two large rounded alternate foliaceous bracteoles

which are situated just below the heads and long-decurrent on the peduncles, up to 30-flowered. *Involucre* uniseriate, up to 2 cm. long; bracts about 10, oblong, subacuminate. *Achenes* oblong-linear, pilose. *Pappus* but slightly exserted from the involucre.

West Tropical Africa.—Angola, Bailundo Div.: Benguello, 1500 m., *Wellmann*! Type (K).

A species remarkable for the fact that it differs widely from the other Tropical African species of the genus in having the capitula enfolded by a pair of large foliaceous bracts. It is thus very closely allied to *L. platyphylla*, from which it differs in the disposition of its leaves, and *L. disticha*, from which it differs chiefly in the much larger and differently shaped leaves with their long-decurrent bases.

4. **L. disticha** (N. E. Br.) S. Moore in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904); and in Journ. Bot. lxvii. 275 (1929).

Othonna disticha N. E. Brown in Kew Bull., 1895, p. 16.

A hemicryptophyte. *Rootstock* a thickened and somewhat woody tuber. *Stems* usually 2 to several from the same rootstock, simple, leafy for the greater part, up to 30 cm. long, ascending-erect, striate, glabrous. *Leaves* distichous, elliptic-obovate to obovate, obtuse or rounded at the apices, somewhat narrowed to the sessile amplexicaul base which is shortly decurrent on the stem, up to 4 cm. long and 3·5 cm. wide, gradually smaller towards the top, more or less fleshy-herbaceous, coriaceous in the dried state, glabrous and glaucescent, usually drying black or dark brown. *Heads* solitary or 2–3 together at the end of the stems, usually partly hidden by the enfolding foliaceous bracteoles, up to 20-flowered. *Involucre* 1-seriate, up to 1·9 cm. long; bracts, 4–5, oblong to oblong-lanceolate, acuminate, almost flat, usually with a more or less evident obtuse keel on the outer face, glabrous. *Achenes* usually oblong in outline, glabrescent. *Pappus* but slightly exserted from the involucre in the fruiting stage.

Transvaal.—Carolina Div.: Waterval Onder, 1300 m., *Crawley in Herb. Trans. Mus.* 10766! (TM). Barberton Div.: Northern Swazieland border, along the upper slopes of the "Bearded Man" Mountain, Makwonga Range, near Barberton, 1300–1500 m., April, *Galpin* 902! type * (B, K, Na, Pa, SM); Malelane, May, *Edwards* 32! (Pa); near Barberton, Nov., *Williams in Herb. Trans. Mus.* 10707! (TM); *Mrs. Saunders in Herb. Wood* 3915! (K, Na); Barberton Mountains, June, *Burtt Davy* 355! (B, Pa). Lydenburg Div.: "Sterk Hill," June, *Burtt Davy* 474! (Pa); near Lydenburg, *Atherstone*! s.n. (K); at Spitzkop Gold Mine, April, *Wilms* 822*a*! (BM); stony places at Lydenburg, Jan., *Wilms* 822! (BM, K), and in *eod. loc.*, March, *Wilms in Herb. Trans. Mus.* 10548! (TM); Sabie, 1100 m., May, *Rogers* 14665! (B), 18817! (BM, Pa), *Moss* 5097! (HM); Pilgrims Rest, Nov., *Rogers* 14906*b* (K), 18715! (K). Pietersburg Div.: Thabina, June, *Rogers* 18918! (AM), and in *Herb. Trans. Mus.* 15909! (TM); The Downs, July, *Rogers* 20245! (Pa); Houtboschberg, 1900 m., March, *Schlechter* 4716! (B, Na); *N. M. Barber* 1! (K), 7! (K); Tzaneen, New Agatha, *Rogers* 18835! (BM).

5. **L. platyphylla** Benth. in Hook. Ic. Pl. xii. 12. t. 1113 (1872); S. Moore in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904); Wood, Revised List Fl., Natal, p. 177 (1908); S. Moore in Journ. Bot. lxvii. 275 (1929).

An erect simple or branched shrub, up to 2 (sometimes 4) m. high. *Stems* moderately

* Three specimens—*Galpin* 902, *Herb. Wood* 3915, *Atherstone* (*sine num.*)—were cited by N. E. Brown under his original description of *Othonna disticha* N. E. Br. (*loc. supra cit.*). Of these Mr. Brown has himself indicated (in Herb. Kew) Galpin's specimen as his type.

stout at the base, marked with old leaf scars higher up. *Branches* (where present) simple, ascending-erect, closely leafy in the upper part, clothed lower down with the persistent and withered remains of old leaves (sometimes, in the smaller specimens, also found on the upper parts of the stem), glabrous in all parts. *Leaves* scattered along the branches, oblong-obovate to obovate, distinctly narrowed towards the sessile base which is decurrent on the stem as a distinct stem-wing, obtusely rounded at the apices, up to 9 cm. long and 6·5 cm. wide, spreading-ascending, becoming reflexed with age, somewhat fleshy-herbaceous, glaucescent and glabrous, usually of a dark to an olive green colour. *Heads* solitary on short shoots and aggregated at the ends of the branches, about 50-flowered, each head enfolded by a pair of large foliaceous bracteoles which are markedly decurrent along the false peduncle. *Involucre* campanulate, 1-seriate, up to 1·8 cm. long; bracts 9, oblong, more or less flat, bluntly tapering to the apices, glabrous. *Achenes* oblong in outline, glabrous. *Pappus* slightly exserted from the involucre.

Natal.—(*Sine loc. exact.*), *Wood*! s.n. (BM); "Highlands of Natal and Zululand," *Gerrard* and *McKen* 2023! Type (K). Alexandra Div.: Dumisa, grassy hill slopes at Ifafa, 550 m., June, *Rudatis* 655! (Be, BM, K); and at Fairfield, on *Protea mellifera* (*sic*) covered slopes, 350 m., July, *Rudatis* 33! (Be); and at Friedenau, on grassy slopes, 600 m., July, *Rudatis* 1429! (Be). Inanda (?) Div.: Side of a stony hill at Eisdumbini, 600 m., April, *Wood* * 5733! (K). Pietermaritzburg Div.: Slopes of the Noodsberg, 950 m., April ("floruit in Horto Botanico Durbanense, 20.10.'97") *Wood* 6540! (Be, BM).

Swazieland.—Hlatikulu, July, *Miss Stewart in Herb. Trans. Mus.* 9904! (TM).

Transvaal.—Barberton Div.: (*Sine loc. exact.*), *Mrs. Saunders in Herb. Wood* 3904! (K, Na, Pa).

6. **L. dregeana** DC., Prodr. vi. 335 (1837); and in Deless. Ic. Sel. Pl. iv. 26, t. 59 (1839); Harv. in Harv. and Sond. Fl. Cap. iii. 315 (1864–65); and Gen. S. Afr. Pl. Ed. 2. 197 (1868); O. Hoffm. in Engl. and Prantl, Nat. Pflanzenfam., IV. v. 295. f. 132, K (1892); S. Moore in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904); Wood, Revised List Flora Nat. 177 (1908); S. Moore in Journ. Bot. lxvii. 275 (1929).

Apparently a hemicryptophyte, with several ascending-erect leafy branches up to 60 cm. long arising from the same rootstock, glabrous in all parts. *Leaves* scattered along the branches (withering and subpersistent near the base of these), oblong-obovate to oblong-elliptic, obtusely rounded at the apices, somewhat narrowed to the 3-nerved sessile base, up to 4 cm. long and 1·8 cm. wide, never decurrent along the branches in the form of a definite stem-wing, subfleshy. *Heads* solitary on abbreviated axillary shoots, aggregated at the apices of the branches, not or scarcely hidden by the upper leaves and never enveloped by a pair of foliaceous bracteoles. *Involucre* 1-seriate, up to 1·8 cm. long; bracts 4–5, oblong to lanceolate-elliptic or elliptic-oblong, shortly acuminate or sometimes distinctly beaked, concave or flat on the inner face, with a broad median longitudinal wing or crest up to 4·5 mm. wide. *Achenes* oblong in outline, glabrous or pubescent. *Pappus* scarcely exserted from the involucre.

Cape Province.—Pondoland, Egossa, *Sim* 2540! (Na); near the sea, on grassy slopes, 30–200 m., *Beyrich* 216! (Be); hill slopes, 200 m., March, *Bachmann* 565! (Be).

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* There is an MS. note in Herb. Kew, under date July 1895, accompanying this number, stating: "I have known this plant for 15 years, but have never been able to get flowers or seed, so in passing Eisdumbini with a wagon in April 1894 I had some plants dug out and brought here (Durban Bot. Gard.), and it has now flowered in mid-winter. . . . I have met with it in this one locality only, viz. Eisdumbini, on the side of a stony hill at an altitude of about 2000 feet above the sea."—J. M. Wood.

Lusikisiki Div.: Between the Umtentu and Umzimkulu Rivers, on grassy slopes, under 150 m., May, *Drège* 5028! Type (Be, BM, Gc, K, Pa); on the side of a hill, near Port Grosvenor, 30–150 m., May, *Bachmann* 1446! (Be).

Natal.—Albert Div.: In open places at Port Shepstone, 90–120 m., May, *Dimock-Brown* 511! (B, BM, Pa); on the side of a hill, between the Umzimkulu River and Murchison, April, *Wood* 3050! (K, Na, SM). Alexandra Div.: Dumisa, on grassy and wooded slopes at Ifafa, 550 m., June, *Rudatis* 656! (Be, BM, K); and on sunny and grassy slopes in the Ifafa valley, 500 m., May, *Rudatis* 979! (Be, BM, K, Pa).

The above species is the type of the generic name.

7. **L. phyllodes** (Hiern.) S. Moore in Journ. Bot. lxvii. 275 (1929).

Vernonia phyllodes Hiern. in Cat. Afr. Pl. Welw. I. iii. 525 (1898).

An erect, yellowish-green herb, up to 60 cm. high, "with the habit of a *Carthamnus*." *Stem* shrubby at the base, branching towards the top, sulcate, terete, glabrous. *Branches* ascending-erect, closely leafy, terete, striate, glabrate below, cottony-hairy towards the apices. *Leaves* scattered and more or less crowded, "arranged after the manner of the phyllodes in the leafless acacias" (Hiern.), oblong-elliptic to ovate-oblong, obtusely rounded at the subapiculate apices, somewhat rounded at the scarcely narrowed 3-nerved non-decurrent subsessile or sessile base, up to 6 cm. long and 2 cm. wide, fleshy-coriaceous, pilose in the younger stages, at length glabrescent, or glabrous and pilose only at the very base. *Heads* campanulate, solitary, and terminating the branches or abbreviated subterminal shoots, or a few aggregated at the apices of the branches, about 35-flowered. *Involucre* spuriously pauciseriate, up to 2·5 cm. long; bracts (comprising the true involucre) 1-seriate, thickly coriaceous and firm, concave, shiny, and glabrous on the inner face, cottony-hairy on the outer face, closely surrounded by several rows of lanceolate-oblong, much-reduced foliage leaves which are pilose-hairy on the outer face and gradually pass into the normal leaves. *Achenes* (immature) glabrous except at the very base. *Pappus* scarcely exserted from the involucre.

West Tropical Africa.—Angola: Pungo Andonga, in wooded thickets by hilly places on the Cuanza River, near Sansamanda (Sange), 700–1100 m., May, *Welwitsch* 3993! Type (BM, K). Cuanja, in herb-grown pasturage between Quitomba and Camabatela, March, *Gossweiler* 7397! (BM). Ambaca, in herb-grown meadows, here and there at Capichango, June, *Gossweiler* 4548! (BM). Loanda, in shrubby pasturage on the right bank of the River Quanze, near Malange, July, *Gossweiler* 1176! (BM). Mundongo, 1400 m., May, *Baum* 927! (Be, BM, K).

The above species is one of the most remarkable in the genus in that it is the only one so far known (with the exception of the next) in which the involucre is so closely surrounded by several rows of much-reduced foliage leaves, and it is probably through a misinterpretation of this character that Hiern. was led (*loc. cit.*) to refer the species to *Vernonia*, for the true involucre is 1-seriate. The style-branches of the species are, however, not those of *Vernonia*, and the anther bases are not sagittate, as in this genus, but obtuse. Nor do the whorls of reduced foliage leaves round the involucre correspond to that condition observable in the pluriseriate involucre of *Vernonia*, while in the matter of vegetative characters, the venation of the leaves of the above species differs from that so far observed in the latter genus.

The species is further of interest in that it appears to be the only one in the genus *Lopholaena* with a definite indumentum on the vegetative parts.

8. **L. acutifolia** R. E. Fries in Wiss. Ergeb. Schwed. Rhod. Kongo-Expedit. 1911–1912· i. 341 (1914).

An erect perennial herb (or suffrutex), up to 40 cm. high, glabrous in all parts. *Stems*

rigid, shrubby at the base, branching towards the middle, sulcate, terete. *Branches* ascending-erect, closely leafy, striate. *Leaves* scattered along the branches, broadly to narrowly elliptic, manifestly tapering to the acute apices, narrowed to the sessile 3–5-nerved base (the latter decurrent along the branches in the form of a distinct wing up to 2 mm. wide), up to 10 cm. long and 2·5 cm. wide, fleshy-coriaceous, rigidly ascending. *Heads* solitary and terminal at the apices of abbreviated axillary shoots, or terminating the branches, about 30-flowered, usually hidden by the uppermost much-reduced leaves. *Involucre* campanulate, 1-seriate, up to 1·8 cm. long; bracts 10, lanceolate to linear-lanceolate, flat, subacuminate, surrounded by several much-reduced foliage leaves in the form of bracteoles. *Ovary* oblong in outline, glabrous. *Pappus* scarcely exserted from the involucre.

South Tropical Africa.—Northwest Rhodesia: Bwana MKubwa, "auf mit Gräsern reichlich bewachsener Lichtung in dem Trockenwald," Aug., *Fries* 365! Type (U, Be).

The species has been well named by Fries, for it appears to be the only one so far known in which the leaves are so markedly acute. In the possession of much-reduced foliaceous bracteoles surrounding the true involucre this species comes near to the preceding, but from this it is readily known by the acute leaves, as well as by the very evident stem-wings.

9. **L. ussanguensis** (O. Hoffm.) S. Moore in Journ. Bot. lxvii. 275 (1929).

Senecio ussanguensis O. Hoffm. in Engl. Bot. Jahrb. xxx. 438 (1901).

An erect shrubby perennial (?), up to 100 cm. high, with leafy, striate, ascending-erect branches, glabrous in all parts. *Leaves* subdecussate, broadly oblong-elliptic to suborbicular, rounded at the apex, obtuse at the sessile amplexicaul 3–7-nerved decurrent base (the stem-wing up to 2–3 cm. long), up to 7 cm. long and 5 cm. wide, ascending-erect, thinly fleshy-herbaceous, with the nerves evanescent towards the apices. *Heads* aggregated in clusters of 2–3 at the apices of the branches, or solitary at the ends of abbreviated shoots, about 30-flowered, scarcely hidden by the upper foliage leaves or reduced foliaceous bracteoles (when present). *Involucre* subcampanulate, up to 1·8 cm. long; bracts 4–5, oblong to ovate, acute or obtuse. *Achenes* oblong-elliptic in outline, densely villous. *Pappus* equalling the florets in length.

South Tropical Africa.—Tanganyika, Ussangu: "Pikurugwe-Rücken, mit Felsblöcken übersäte Abhänge," 2900 m., Sept., *Goetze* 1257! Type (Be).

This species comes nearest to *L. decurrens* (Hutch.) and *L. disticha* (N. E. Br.), but differs, *inter alia*, in the absence of 2–3-foliaceous bracteoles enveloping the capitula, as well as in the habit.

10. **L. glaucescens** Phill. and C. A. Sm., nom. nov.

L. bainesii S. Moore in Journ. Bot. lxvii. 275 (1929), quoad descr. tanti., sed non *Othonna bainesii* Oliv. and Hiern.

Othonna coriifolia Hiern. Cat. Welw. Afr. Pl. I. iii. 603 (1898), excl. syn.; non Sond.

An erect glaucescent shrublet or undershrub, glabrous in all parts. *Stems* up to 60 cm. high, arising several from the same woody rootstock, simple, closely leafy, striate. *Leaves* scattered along the stems, elliptic or oblong-lanceolate, markedly tapering towards either extremity, acute at the apex, up to 6 cm. long and 2·5 cm. wide, subfleshy or fleshy-coriaceous, prominently 3–5-nerved at the sessile non-decurrent base, with the nerves at first subparallel, at length converging towards the apex. *Heads* axillary and terminal on short abbreviated axillary shoots, up to 10-flowered; each shoot bearing 3–4 very shortly pedicelled capitula subracemosely disposed and arising from the axils of small foliaceous bracteoles. *Involucre* campanulate-cylindric, up to 1·8 cm. long; bracts 5–6, lanceolate to lanceolate-oblong, more or less flat. *Achenes* oblong in outline,

conspicuously white-hairy; those of the inner florets sterile and glabrescent. *Pappus* exserted for about half its length.

South Tropical Africa.—Angola, Huilla Div.: In rocky thickets near Mumpulla, 1200–1350 m., Oct., *Welwitsch* 3991! Type (K, BM).

From the key characters given by S. Moore—"leaves oblong-lanceolate, up to 5 cm. long. *Heads* 5-flowered" (*loc. supra cit.*)—it appears that he based his conception of *L. bainesii* on *Welwitsch* 3991, which agrees with the diagnosis, but this certainly does not apply to the type of *Othonna bainesii* O. & H., which has shorter obovate leaves and capitula up to 20-flowered.

11. **L. coriifolia** (Sond.) Phill. & C. A. Sm., comb. nov.

Othonna coriifolia Sond. in Harv. and Sond., Fl. Cap. iii. 333 (1864–65).

O. bainesii Oliv. and Hiern. in Oliv. Fl. Trop. Afr. iii. 423 (1877).

Lopholaena randii S. Moore in Journ. Bot. xli. 133 (1903); and in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904); Eyles in Trans. Roy. Soc. S. Afr. v. 517 (1916); S. Moore in Journ. Bot. lxvii. 275 (1929), incl. var. *brachycephala* S. Moore (*loc. cit.*, p. 275).

L. bainesii S. Moore in Journ. Bot. 67. 275 (1929), quoad syn. tant.

A bushily branched, rigidly erect perennial shrub, up to 100 cm. high, glabrous in all parts. *Stems* up to 4 cm. (or more?) thick at the base, soon becoming very much branched. *Branches* ascending-erect, in their turn becoming much branched, with the branchlets closely leafy for the greater part, bare or, usually, covered with the withered remains of old persistent leaves lower down. *Leaves* scattered, obovate to oblong-obovate, obtuse or quite rounded at the apices, more or less conspicuously narrowed towards the 1–3-nerved base (the latter sometimes very shortly but obscurely decurrent on the branches), up to 4 cm. long and 1·8 cm. wide, fleshy-coriaceous, subglaucescent. *Heads* solitary on abbreviated bracteolate axillary or subterminal shoots usually aggregated at the ends of the branches, up to 20-flowered. *Involucre* campanulate-cylindric, 1-seriate and without whorls of foliaceous bracteoles; bracts 5, very rarely 6, oblong to ovate-lanceolate, shortly acuminate but obtuse at the apex, concave within, convex without, with an obtusely rounded keel or "cushion." *Ovary* (*Achenes*) usually oblong in outline, glabrous or more usually silky white-hairy. *Pappus* somewhat exserted from the involucre.

Transvaal.—Heidelberg Div.: At Heidelberg, 1600 m., Nov., *Miss Leendertz* 8082! (TM). Witwatersrand Div.: Randfontein, Oct., *Moss* 5084! (HM); Kensington, kopjies, Johannesburg, 1800 m., Sept., *Miss Gilmore* 5251 (Pa); Kopjie near the Johannesburg Zoo lake, 1800 m., Aug., *van Nouhuys* 2! (Pa); on a ridge north of Belgravia, 1800 m., Sept., *Gilfillan* 284! (Pa); near Roodepoort, Oct., *Moss* 7989! (HM); rocky places in the neighbourhood of Johannesburg, 1800 m., Sept., *Rand* 746! Type of *L. randii* (BM), Park View kopjies, Johannesburg, Aug., *Weeks* 8! (HM). Pretoria Div.: On the Magaliesberg, 1650–1800 m., July, *Burke*! s.n. (K), *Zeyher* 944! Type (Herb. Sonder); kopjie behind Pretoria Zoo, 1350 m., Sept., *Mogg* in *Govt. Herb.* 10588! (Pa), *Moss* 6885! (HM); Pretoria kopjies, Aug., *Miss Leendertz* 220! (Al, Na, TM); north slopes of Meintjies kop, Pretoria, 1450 m., Sept., *Burtt Davy* 5053! (Pa); Magaliesberg slopes at Wonderboom, Aug., *Burtt Davy* 2274! (B); Premier Mine, Oct., *Moss* 5083! (HM). Rustenburg Div.: On the Magaliesberg near Rustenburg, Oct., *Miss Pegler* 926! (B); *Bell-John in Herb. Moss* 13310! (HM). Lydenburg Div.: Pilgrims Rest, Aug., *Edwards in Herb. Moss* 10167! (HM); at Waterval Boven, 1200 m., June–Oct., *Rogers* 641! (B), 2384! (K), 2712! (Al), 12236! (TM); *Miss Mason* 138! (K); Rosehaugh, *Sim in Herb. Mus. Austro-Afr.* 7245! (SM); Belfast, 1950 m., Dec., *Miss Leendertz* 7945! (TM). Barberton Div.: Ivy Range, Moodies, 1500 m., Aug., *Thorncroft* 362! (K). Pietersburg Div.: Houtbosch, Sept., *Jenkins in Herb. Trans. Mus.* 7197! (K, TM).

South Tropical Africa.—Southern Rhodesia (*sine loc. exact.*), *Hislop*, Z148! Makoni, on exposed summit of a mountain, 1600 m., July, *Eyles* 741! Type of *L. randii* var. *brachycephala* (BM, K, SM); Marandellao, "pre-rain flora," Sept., *Walters* 2386! (BM). Mashonaland, "South African Goldfields," *Baines*! s. n. Type of *Othonna bainesii* (K).

The characters given by Spencer Moore (*loc. supra cit.*)—". . . involucris brevioribus (vix 1 cm. long), flosculisque paucioribus (13)"—as distinguishing his *L. randii* var. *brachycephala* from the type, are so well linked up with the "typical" form by intermediate stages when a large number of specimens of the above species are examined, that it does not appear desirable to maintain its varietal rank. Nor can *O. bainesii* O. & H. be kept separate from the above species on any reliable character, the only apparent difference being found in the slightly larger leaves, and even this is not constant.

The plant above described is very commonly met with on the Pretoria kopjies and on the Magaliesberg slopes, where it almost invariably favours the summit or northern aspect. It generally grows in very rocky and bouldery situations, and forms a very conspicuous feature of these slopes during the fruiting stages, when the involucres break open to liberate the fruits with their copious white pappus.

12. **L. cneorifolia** (DC.) S. Moore in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904); and in Journ. Bot. lxvii. 275 (1929).

Doria cneorifolia DC. Prodr. vi. 470 (1837); Harv. in Harv. and Sond. Fl. Cap. iii. 321 (1864–65).

Othonna cneorifolia Sch. Bip. in Flora, xxvii. 769 (1844); Hutch. in Ann. S. Afr. Mus. ix. 409 (1917).

Hertia cneorifolia O. Kuntze, Rev. Gen. Pl. I. i. 344 (1891).

* *Othonnopsis cneorifolia* "Benth." ex Ind. Kew. ii. 384 (1895).

An erect, rigid, bushy perennial shrub, up to 90 (or more?) cm. high, glabrous in all parts. *Stems* stout at the base, soon becoming bushily much branched. *Branches* ascending-erect, somewhat rugose and tubercled on the older parts, more or less nude, with many closely leafy branchlets. *Leaves* scattered, obtuse or rounded at the apices, distinctly cuneate towards the sessile 1-nerved base (not decurrent), oblanceolate to obovate-oblanceolate, up to 4 cm. long and 8 mm. wide, fleshy-coriaceous and moderately thick in texture, sometimes appearing minutely punctulate or pitted, glabrous and glaucescent. *Heads* aggregated at the apices of the branches (or branchlets), in a bracteolate false panicle, not or only partly hidden by the upper foliage leaves, 5–8-flowered. *Involucre* cylindric-campanulate, 1-seriate, up to 1·4 cm. long, glaucescent; bracts 5–6, lanceolate to oblong-lanceolate, obtuse, concave within, convex and ecarinate without. *Achenes* oblong in outline, glabrous. *Pappus* about as long as the involucre, or scarcely exserted.

Western Region.—Little Namaqualand (*sine loc. exact.*), *Scully*! s.n. (K); between Pedro's Kloof and Leliefontein, 900–1200 m., Nov., *Drège*! Type (Be, Gc, K); south-west of Leliefontein Mission Station, in granite crevices on a kopjie, Jan., *Pearson* 6316! (K, SM); near Concordia, 900 m., Sept., *Bolus* 9587! (B, K); top of Ratel Poort Mountain, Dec., *Pearson* 2983! (K, SM); near summit of Vogelklip, in crevices of bare rock, Dec., *Pearson* 5935! (K, SM); Khamiesberg, in Groenkloof, among rocks above a stream, Sept., *Pearson* 6616! (K, SM), and among rocks near the summit of "Beacon Hill 2," Sept., *Pearson* 6634! (K, SM). Great Namaqualand, Gubub, *Dinter* 1178! (BM); Moltkeblick, 2400 m., May, *Dinter* 3510! (BM).

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* In the Index Kewensis this combination is attributed to Bentham, Gen. Pl. ii. 451, but as Bentham here merely cites *Doria cneorifolia* as one of the species to be referred to *Othonnopsis*, this combination has no status.

Griqualand West.—Hay Div.: At Klipfontein, June, *Burchell* 2159! (K), and *eod. loc.*, Dec., *Burchell* 2630! (K); at Dunmurry, July, *Mrs. Coote in Herb. McGreg. Mus.* 2321! (K).

This species has much the same habit as that of *Hertia pallens* (DC.) O. Kuntze, but is allied to the next species, from which it differs in the very different arrangement of the capitula on the branchlets and branches, in addition to occupying very different phytogeographical areas.

It is of interest, too, to note that the above species frequents an exactly similar habitat to that of *L. coriifolia* (Sond.), Nob., and in very different regions.

13. **L. brevipes** Phill. and C. A. Sm., sp. nov.

Senecio dolichopappus O. Hoffm. in Engl. Bot. Jahrb. xxx. 438 (1901), *pro majore parte*; excl. t. 18, ff. F–G.

Suffrutex. Folia ad 4 cm. longa, 4 mm. lata, obovato-oblanceolata vel lineare-oblanceolata, apice acuta vel obtusa. *Capitula* solitaria, cylindrico-campanulata; bracteae 4–5, oblongae, apice acutae. *Pappus* bracteis aequilongus.

Suffruticose, much branched, erect, up to 35 cm. high, glabrous in all parts. *Branches* more or less rigidly ascending-erect, with numerous shorter laterals. *Branchlets* closely leafy, the uppermost terminating in a single capitulum. *Leaves* scattered, narrowly obovate-oblanceolate to linear-oblanceolate, subacute or obtuse at the apices, long-cuneate to the sessile 1-nerved non-decurrent base as if drawn out into a short petiole, up to 4 cm. long and 4 mm. wide, fleshy-coriaceous, occasionally with much abbreviated axillary tufts of leaves. *Heads* shortly peduncled, solitary and terminal, scarcely hidden by the uppermost foliage leaves, 5–6-flowered. *Involucre* cylindric-campanulate, 1-seriate, up to 1·4 cm. long, subglaucescent; bracts 4–5, oblong to linear-oblong, acute, convex without, concave or almost flat within. *Achenes* ovoid, compressed, glabrous. *Pappus* about as long as the involucre and scarcely exserted from it.

South Tropical Africa.—Tanganyika: Usafua, on dry slopes covered with short grass on the Beya Mountain, 2700 m., June, *Goetze* 1075! Type (Be, BM). British Central Africa, Nyika Plateau, Nov., *Henderson*! s.n. (BM).

See note under *L. dolichopappa* (O. Hoffm.) S. Moore.

14. **L. whyteana** (Britt.) Phill. and C. A. Sm., comb. nov.

Othonna whyteana Britten in Trans. Linn. Soc. Bot. ser. 2. iv. 21. t. 4, ff. 1–2 (1894).

An erect half-shrub or subfruticose perennial (?), up to 75 cm. high, with numerous wand-like stems arising from the same rootstock, glabrous in all parts, becoming much branched above the middle. *Branches* erect or suberect, closely leafy. *Leaves* scattered, obovate-spathulate to obovate, subacute to rounded at the apices, much narrowed to the sessile 1-nerved non-decurrent base, up to 6 cm. long and 1·5 cm. wide, fleshy. *Heads* long-peduncled (with the peduncles axillary, up to 8 cm. long and confined to the upper part of the branches), terminal and solitary, 5–6-flowered. *Involucre* cylindric-campanulate, 1-seriate, up to 1·5 cm. long, at first entire in the lower two-thirds, at length splitting into segments, glaucescent; bracts 5, lanceolate, acuminate, without enveloping foliaceous bracteoles. *Achenes* oblong in outline, glabrous or with only a few hairs. *Pappus* (in fruit) much exserted from the involucre.

South Tropical Africa.—Tanganyika: Mount Milanji, 1800 m., Oct., *Whyte* 62! Type (BM). Iringa Province, at Lupembe, 1800 m., Nov., *Haarer* 1586! (K).

15. **L. dolichopappa** (O. Hoffm.) S. Moore in Bull. Herb. Boiss. sér. 2. iv. 1021 (1904); and in Journ. Bot. lxvii. 275 (1929).

Senecio dolichopappa O. Hoffm. in Engl. Bot. Jahrb. xxx. 438 (1901), *pro minima parte*, incl. t. 18, ff. F–G.

Branchlets short and closely leafy, glabrous in all parts. *Leaves* scattered, narrowly linear-oblanceolate to narrowly linear, subacute to obtuse or blunt at the apices, gradually tapering to the narrow sessile 1-nerved non-decurrent base, up to 4 cm. long and 1·5 mm. wide, fleshy coriaceous, frequently with abbreviated axillary leaf-tufts. *Heads* long-peduncled (with the peduncles up to 2–3 times as long as the leaves, axillary in the axils of the uppermost leaves of each branch), terminal and solitary, 5–6-flowered. *Involucre* cylindric-campanulate, up to 1·5 cm. long, glaucescent; bracts oblong to oblong-linear, about 4 to 5, acute at the apices. *Achenes* oblong-elliptic in outline, glabrous. *Pappus* much exserted from, and about one and a half times as long as, the involucre.

South Tropical Africa.—Tanganyika: Umalila, on the slopes of Uwurungu Mountain, 2200 m., Nov., *Goetze* 1462! Type (Be, BM).

In describing his *Senecio dolichopappus*, O. Hoffm. (*loc. supra cit.*) cites two Tanganyika specimens—*Goetze* 1075, from "Usafua: Beya-Berg, auf trockenen abhangen mit kurzen gras, 2700 m.," collected in June 1899, and *Goetze* 1462, from "Umlalila: Uwurungu-Berg, auf rasigen Abhangen, 2200 m.," collected in November 1899—as syntype specimens of that species, parts of both specimens being figured (*op. cit.*, t. 18). Examination of the type numbers in Herb. Mus. Brit. showed two specimens which are almost exact duplicates of the specimens represented in the excellent plate already cited. Of the two numbers, *Goetze* 1075 is represented by ff. A–E, which show a flowering branch with details of structure of a single floret-style, anthers, etc., and *Goetze* 1462 by ff. F–G, which show a single twig with the characteristic long-exserted shaving brush-like pappus of each of the fruiting capitula (f. F), and a single achene with its long pappus (f. G). The two *Goetze* specimens, however, seen side by side, present such marked differences (very well to be seen also in the plate cited) that there can be very little doubt that two distinct species are involved. Thus No. 1075 differs from No. 1462 in the *very short terminal* peduncles, which, like those of *L. cneorifolia* (DC.) S. Moore, *L. coriifolia* (Sond.) Nob., do not (so far as is known) elongate towards the fruiting period, as well as in foliage characters, and, since it cannot be referred to any of the known species of the genus *Lopholaena*, of which it is undoubtedly a member, it has been treated as the type of a hitherto undescribed species. It certainly cannot be considered as the type specimen of *Senecio dolichopappus* O. Hoffm., since it is quite obvious that the specific epithet was framed for the fruiting specimen (*Goetze* 1462), which, as has been noted, shows the long and exserted pappus. It follows then that this latter number (1462) must be regarded as the type number of O. Hoffmann's species. In the absence of flowering material of this plant, it was a matter of some doubt as to whether it should be referred to *Lopholaena*, as S. Moore had already done (*loc. supra cit.*), but the very close agreement of the specimen with such species of the genus as *L. whyteana* (Britt.) Nob. and *L. pauciflora* Thell., in the character of the fruiting pappus and much elongated peduncles, lends reasonable security to the transfer.

16. **L. pauciflora** Thell. in Mitt. Bot. Mus. Univ. Zür. xcii. 242 (1921).

A much-branched perennial suffruticose glabrous in all parts. *Branches* ascending-erect, striate, up to 40 cm. long. *Branchlets* closely leafy, up to 10 cm. long, narrowly ridged with the decurrent leaf-bases. *Leaves* scattered, linear-oblanceolate to linear-spathulate, acute or obtuse at the apices, with a short cartilaginous apiculus, noticeably cuneate towards the sessile 1-nerved narrowly decurrent base, up to 3 cm. long and 3·5 mm. wide, coriaceous in the dried state and strongly rugose or wrinkled, often with axillary much-abbreviated shoots or leaf-tufts, or slightly woolly in the axils. *Heads* on long

peduncles (the latter slender, axillary, up to 5 cm. long and collected towards the apices of the branchlets), 3–4-flowered. *Involucre* cylindric-campanulate, 1-seriate, up to 1·2 cm. long; bracts 3–4, oblong-linear, at first connate for the greater part of their length, eventually (in the fruiting stages) free. *Achenes* (immature) compressed, glabrous or very faintly puberulous. *Pappus* long-exserted from, and about one and a half times as long as, the involucre, exceeding the florets.

South Tropical Africa.—Nyassa Highlands, at Kyumbila, *Stolz* 2267, Type (Herb. Mus. Bot. Univ. Zurich).

We have unfortunately been unable to examine the type of the above species, but from the excellent and detailed original description the species seems to be very closely allied to *L. dolichopappa* (O. Hoffm.) S. Moore, differing from the latter in the differently shaped leaves, in their decurrent margins, and in the longer peduncles and fewer-flowered heads.

17. **L. longipes** (Harv.) Thell. in Mitt. Bot. Mus. Univ. Zür. xcii. 243 (1921), in obs.
Doria longipes Harv. in Harv. and Sond., Fl. Cap. iii. 322 (1864–65).

Apparently a much-branched, glabrous shrub. *Branches* terete, ramulous. *Branchlets* closely leafy. *Leaves* scattered, obovate-oblanceolate, acute at the apices, tapering to the sessile 1-nerved non-decurrent base, up to 3·8 cm. long and 6 mm. wide, fleshy, shrinking when dry. *Heads* long-peduncled (with the peduncles terminal and subterminal, slender, up to 2–3 times as long as the leaves), 5–6(?)-flowered. *Involucre* uniseriate, up to 1·4 cm. long; scales 5–6, linear-oblong, subacute. *Achenes* (immature) compressed, thinly silky hairy. *Pappus* probably much exserted from the involucre.

Little Namaqualand.—Modderfontein, *Whitehead*, s.n. Type (Herb. Trin. Coll. Dublin).

We have not seen the type of the above species, but from the description given by Harvey in the Flora Capensis it can hardly be excluded from *Lopholaena*, as Thellung wisely saw. This author also regards the above as very closely allied to his *L. pauciflora*, and points out that the differences appear to be purely quantitative, but correctly lays stress on the fact that the two species occur in very widely separated and different phytogeographical areas.

ISOLATION OF A GLUCOSIDE FROM *GNIDIA POLYCEPHALA* (JANUARIE BOSSIE).

By M. Rindl,

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My earlier investigation of this plant (then known as *Arthrosolen* or *Lasiosiphon polycephalus*) made it appear likely that it contains daphnin.* Repeated attempts were made to obtain the glucoside from plant material which had been stored for several years, but in all cases with negative results. In Europe the usual source of daphnin is the bark of *Daphne Mezereum* L. and *Daphne alpina* L., but it can be obtained only from fresh plant material.† It therefore seemed likely that in this case also it might be possible to isolate the glucoside from fresh *Gnidia*. Some of this material was therefore collected at the flowering stage in September and October in the vicinity of Bloemfontein.

Daphnetin had previously been isolated from the aerial portions of the plant. These were, therefore, separated from the roots and examined separately. They were cut into short lengths and ground in a meat mincer. The dust of this finely ground material has an irritant and persistent action on the mucous membranes of the nose, suggesting the presence of a saponin. But the finely ground plant material does not respond to the usual tests for saponins.

The following method of extraction was finally adopted: the crushed material was extracted by continuous percolation with hot rectified spirits in a copper Soxhlet. The extract was poured into an open dish, the greater part of the solvent removed by spontaneous evaporation, and the thick pasty green extract was treated repeatedly with cold ether. This process was repeated until the ether extracts were only slightly coloured. The residual brown paste was thereupon treated repeatedly with small amounts of cold methanol. A brown solution was formed, whilst two easily separable products remained in suspension. One of these was granular and heavy enough to rapidly settle to the bottom of the liquid. It could be separated by decantation. The lighter product remained suspended and was so finely divided that it could be completely separated

* Trans. Roy. Soc. S. Afr., vol. vi, pt. 4, 1917, p. 295.

† Ber., 63 (1930), p. 1300.

from the liquid only by filtration under suction. It is a glucoside being hydrolysed by dilute hydrochloric acid, and reducing Fehling's solution only after hydrolysis. The methanol filtrate, which contained products of an alkaloidal nature, was reserved for subsequent investigation.

The granular precipitate was purified by repeatedly shaking up with cold methanol. Part of it was subsequently crystallised from hot alcohol, in which it is very sparingly soluble. Its crystalline form and sweet taste suggest cane sugar. Melting-point (uncorr.), 182–184° C. Mixed melting-point with cane sugar, 182–184° C.

The bulk of the material had to be deferred for some months. In order to prevent decomposition of the glucoside the ground plant material was meanwhile kept in jars under alcohol. The method which had proved successful with the first batch, namely, the separation of the specifically heavier granular cane sugar from the lighter glucoside by sedimentation, could not be applied in this case. The amount of sucrose was small, and the solution contained a considerable amount of yellow dye from the flowers, which could be removed only with difficulty. The difference in behaviour of this material may be due to several causes : to prolonged standing and consequent partial loss of the glucoside, or to partial hydrolysis of the sugar. Moreover, a portion of the material had been collected at a later date than the rest, and may have contained a larger proportion of flowers yielding the yellow pigment.

In the first stages of the extraction process the previously described procedure was closely followed, except that the alcoholic extract was concentrated under reduced pressure, and that ethyl alcohol was substituted for the more expensive methanol when the concentrated extract was worked up. In concentrating the original alcoholic extract under reduced pressure granular crystals separated out on the walls of the flask. Instead of separating by sedimentation as previously described, the sucrose was extracted from the brown granular residue by repeatedly extracting with boiling 80 per cent. alcohol. On cooling, a brown gelatinous deposit was formed, which was filtered off and the filtrate evaporated to dryness. The residue was treated with hot water and filtered. On cooling it deposits yellow crystals of impure glucoside. The mother liquor, on evaporation, contained some glucoside mixed with appreciable quantities of partly hydrolysed sugar and, when sufficiently concentrated, turned to a black, viscous liquid containing the glucoside in suspension in a very finely divided form. The material which separated out was sometimes quite slimy, like a fungoid growth, but on drying on a porous plate it formed a felt-like mass of interlaced needles. These were purified first by recrystallisation from methanol, in which they are sparingly soluble, and subsequently from boiling water. The product separates from water as a felt-like pad.

It crystallises from methanol in what appear to be rectangular prisms capped at one end by pyramids. Melting-point, 193–194° C. (corr. 197–198° C.), with partial decomposition. In a vacuum melting-point tube the same value was obtained.

The substance is almost insoluble in ethyl alcohol, chloroform, and ethyl acetate; it is very sparingly soluble in acetone, from which it separates in long pointed needles. On alkalinising with caustic soda after hydrolysis the solution turns yellow, suggesting that it is a glucoside of a dioxycoumarin. On heating the glucoside with very dilute hydrochloric acid on the water-bath it goes into solution, and on cooling feathery crystals separate out in a felt-like mass and may be purified by recrystallising from water with a little norite. In a closed tube this product melts at 255–257° C., whilst a mixed melting-point with daphnetin is 254–256° C. The aglucon therefore appears to be daphnetin. But the glucoside is not daphnin. The melting-point of daphnin is recorded by Wessely and Sturm as 215° C.,* by Asai as 223–224° C.† (not 200° C. as recorded in the earlier literature). It is readily soluble in hot methanol and ethanol, and crystallises with 1 molecule of water of crystallisation. The present glucoside melts at 197–198° C., is practically insoluble in ethanol and sparingly soluble in hot methanol, and is slightly hygroscopic, taking up varying quantities of moisture up to nearly 3 per cent. after drying to constant weight in a vacuum desiccator. Dr. Wessely of the II Chemical Institute of the University of Vienna kindly placed a small amount of daphnin at my disposal, which with my product gave the following mixed melting-points: 145–155, 170–175, 169–177, 169–180, 170–174° C.

When extracting the glucoside with absolute alcohol prior to purification for analysis it was found that a very small amount went into solution which had a melting-point higher than that of the glucoside. This impurity was subjected to continuous hot percolation with ethyl acetate in a Soxhlet. The crystalline product thus obtained melts at 206–208° C. (corr. 211–213° C.) and gives a mixed melting-point with Wessely's pure daphnin of 204–208° C. The impurity accompanying the glucoside therefore appears to be daphnin. The amount available is as yet insufficient for complete purification and analysis. Whether recrystallised from water or methanol the main glucoside has the same melting-point and attracts moisture on exposure to air. This property has occasioned considerable difficulty in obtaining concordant analytical figures.

Material recrystallised from methanol heated to constant weight in Abderhalden vacuum apparatus (80–90° C., 5–15 mm.): 0·0275, 0·0350 gram

* Ber., 63 (1930), p. 1300.

† Acta Phytochimica, vol. v, No. 1, 1930, p. 10; see also Hattori, Journal of the Pharmaceutical Society of Japan, No. 580 (vol. l, No. 6), June 1930, p. 83.

substance; loss 0·0007 and 0·0008 gram; H_2O 2·55 per cent., 2·26 per cent.

Substance dehydrated to constant weight: I (air oven 110° C.), C 51·7 per cent., H 5·5 per cent; II (vacuum drying apparatus), C 51·45 per cent., H 5·3 per cent.

Calc. $C_{15}H_{16}O_9 + \frac{1}{2}H_2O$. C 51·58 per cent., H 4·87 per cent.

Calculated $\frac{1}{2}H_2O$ on $C_{15}H_{16}O_9 + H_2O$, 2·51 per cent.

The results of the analyses corresponded fairly well with the formula for daphnin with $\frac{1}{2}H_2O$, whilst the loss of weight on heating indicates that the substance originally had 1 molecule of water, of which it lost $\frac{1}{2}$ molecule. In view of the readiness with which the substance takes up moisture on exposure to air the somewhat high values for hydrogen can easily be accounted for. However, the analytical figures are only put forward tentatively, pending the accumulation of a larger number of concordant determinations.

Daphnin crystallises with $1H_2O$, which it loses entirely at 80–90° C. and 0·2 mm.*

Endeavours to determine the molecular weight by the Rast micro-method had to be abandoned as the substance charred without dissolving in the camphor.

In order to determine the percentage of aglucon, 0·287 gram of glucoside was dissolved in water, heated for a few minutes over the flame with a few drops of very dilute hydrochloric acid and allowed to cool. The solution was cooled in ice and the precipitated daphnetin filtered, dried, and weighed. Weight of daphnetin 0·146 gram = 50·9 per cent. Calculated for $C_{15}H_{16}O_9 + H_2O$, 50·0 per cent.

In order to prepare the osazone of the sugar the glucoside was hydrolysed with a very small amount of dilute hydrochloric acid, thoroughly cooled, and filtered off from the precipitated daphnetin. The filtrate was evaporated down with sodium acetate, a few drops of glacial acetic acid and freshly distilled phenyl hydrazine added, and the whole heated on the water-bath for about ten minutes. On addition of a little water the osazone separates out, melting at 200° C. Mixed melting-point with glucosazone, 199–199·5° C. (all melting-points uncorrected). The osazone of the sugar is therefore identical with glucosazone.

Attempts to determine the percentage of aldehydic sugar by oxidation with standard iodine in alkaline solution and titration of the excess of iodine gave inconclusive results. The reason for the discrepant results is probably to be sought for in the fact that the quantities handled were extremely small and the method employed is not a micro-method.

For the determination of the rotation 0·0485 gram was dissolved in

* Ber., 63 (1930), p. 1300.

hot methanol in a stoppered conical flask and solvent added until the solution ceased to deposit crystals on cooling. This point was reached when 14·12 grams of solvent had been added, but it subsequently transpired that this was a supersaturated solution which, on prolonged standing, crystallised. The solution after standing for several days contained 0·0092 gram of glucoside in 3·9212 grams of solvent = 0·235 per cent.

$$[\alpha]_D^{23} = +0{\cdot}05 \times 14{\cdot}12/4 \times 0{\cdot}0485 \times 0{\cdot}7955 = +4{\cdot}57 \text{ (4 dm. tube).}$$

It is noteworthy that the rotation is dextro, whilst most natural glucosides are lævorotatory. Daphnin is given as $[\alpha]_D^{22} - 114{\cdot}66$ to $-123{\cdot}92$ * and $[\alpha]_D^{15} - 84{\cdot}2$.† The isomeric daphnetin glucoside prepared by Leone $[\alpha]_D^{20} = -29{\cdot}4$ ‡ and $[\alpha]_D^{15} + 28{\cdot}0$.§

Whilst the saturated solution of the *Gnidia* glucoside contains only 0·235 per cent. the solution of daphnin in methanol used by Wessely and Sturm ‖ to determine the rotation contained 0·0171 gram of glucoside in 4·0093 grams of solvent = 0·42 per cent.

Summary and Conclusions.

The isolation of daphnetin from the aerial portions of this plant, described in an earlier publication, made it seem likely that the glucoside daphnin is present. Repeated attempts to obtain this compound resulted finally in the isolation of a glucoside of daphnetin which does not appear to be identical with daphnin. On account of its hygroscopic nature it is difficult to analyse. The analytical figures, although not sufficiently concordant to allow of definite conclusions, make it probable that the two glucosides have the same empirical formula. Moreover, the *Gnidia* glucoside contains the same percentage of aglucon (daphnetin) and its sugar gives phenylglucosazone. But the *Gnidia* glucoside differs from daphnin in the following respects: (1) it melts at 193–194° C. (corr. 197–198° C.) as against 215° C. (223–224° C.); (2) it gives a considerable depression in a mixed melt with daphnin; (3) after drying to constant weight in a desiccator it attracts up to 3 per cent. of moisture on exposure to air; (4) it is hardly soluble in hot ethyl alcohol and much less soluble in methanol than daphnin; (5) it is slightly dextrorotatory in methanol solution whilst daphnin is lævorotatory.

The above glucoside is accompanied by traces of a second glucoside

* Ber., 63 (1930), p. 1300.

† Hattori, Journ. Pharm. Soc. Japan, No. 580 (vol. l, No. 6), June 1930, p. 83.

‡ Gazz. chim. Ital., 55 (1925), p. 673.

§ Hattori, *loc. cit.*, p. 84.

‖ Ber., 63 (1930), p. 1300.

which, judging by melting-point and mixed melting-point, appears to be daphnin.

The investigation is being continued.

Acknowledgments are made to the following demonstrators and students for assistance rendered: Messrs. Sapiro, Yeld, Groenewoud, Pellissier, Geldenhuys, and van der Walt. The author also desires to place on record his indebtedness to the Research Grant Board of the Union for a research grant, part of which was used to defray the cost of the investigation.

A NOTE ON THE FLORAL EVOLUTIONARY TENDENCIES, DIFFERENTIATION, AND DISTRIBUTION OF THE SOUTH AFRICAN *LABIATAE*.

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The *Labiatae* form a very natural and fairly distinct family among the flowering plants, and floristically have been highly successful in their evolution. They are closely related to the *Boraginaceae*, which exhibit a tendency towards the reduction of the number of stamens and zygomorphy, and which form the transitional group between the *Multiovulateae* with non-schizocarpic fruits and the *Diovulateae* with schizocarpic fruits. In this circle of affinity it is quite evident that the *Labiatae* must have originated from forms like the tropical trees, *Cordia* and *Ehretia*, which have central styles and drupaceous fruits. The *Labiatae*, however, exhibit a distinct progressive tendency towards the reduction of the number of stamens to a number less than the number of petals. The schizocarpic fruit of the *Boraginaceae*, the *Labiatae*, and other *Tubiflorae* affords a method of providing a protective fruit body for each individual seed.

In response to insect visits the *Labiatae*, like many other families, exhibit successful differentiation, and in many of the genera pollination is carried out extraordinarily effectively. The complex methods of securing pollination are obtained without much expenditure of material. As a matter of fact we find that where the pollination mechanism is very highly evolved, there usually is a further reduction of the stamens and anther cells, which makes up for the outlay. Thus the economy rule is more or less observed.

Stress is here laid on pollination and a schizocarpic condition of fruit, because in this we have the main principles underlying the evolutionary history of this highly specialised family.

The evolutionary trends of the *Labiatae* having been mentioned, it will now only be necessary to deal with their general differentiation. The inflorescence is usually more or less dense, the flowers being arranged in cymose verticillasters, which is a very characteristic feature. The verticillasters are found towards the ends of the branches forming lax to rather

dense racemes, except in the genus *Pycnostachys* which has the flowers arranged in dense spikes.

On the whole the flowers are advanced, being zygomorphic; the corolla is very seldom subregular, e.g. *Iboza*. The flowers are usually brightly coloured and often large, *e.g.* species of *Leonotis*, as well as densely crowded for the purpose of attracting the attention of insect visitors and honey-birds, e.g. *Leonotis*. All these characters are a mark of advance.

The honey secreting organs are placed below the ovary on the disc near the base of the corolla tube. By various devices the honey is usually well concealed. In *Ajuga, Leonotis*, etc., the corolla tube is annular pilose within. In *Leonotis* spp. and *Leucas glabrata* the upper lip of the corolla is provided with long hairs, which hang downwards and form a barrier to unwelcome insect visitors. Another advance in this direction is seen in *Plectranthus* and *Pycnostachys*, where the corolla tube is abruptly bent towards about half-way above its base. Where the lower stamens and the style ascend, e.g. *Stachyeae, Salvieae*, etc., both their filaments and their style assist in closing the easy passage to the honey glands. This function is also met with when the stamens and style descend on to the lower lip, e.g. *Ocimeae*. In some of the *Ocimeae*, *e.g.* species of *Ocimum, Orthosiphon*, etc., the filaments of the upper pair of stamens have a knee-like bend at the base and are often toothed or crested, which certainly carries the concealment of the honey a step further. Besides the ascending stamens in the *Salvieae*, some of the species, e.g. *Salvia radula*, have two fairly large empty anther-thecae at the lower end of the connective. These are placed in such a way as to close the corolla tube completely. This shows that this genus has advanced very far towards efficient pollination.

The persistent calyx plays an important part in the protection of the ovary. The disadvantage of a superior ovary is largely overcome by the persistency of the calyx. In this function it is assisted by the fairly large persistent bracts as well as by the dense aggregation of the flowers. *Pycnostachys* is the only genus which has rigid spiny calyx teeth of which the function is quite obvious.

Together with the features discussed above, the corolla is usually two-lipped. The lower lip provides a landing-place for insect visitors. For this purpose it is usually large and spreading in some genera, e.g. *Salvia, Ajuga, Stachys, Tinnea, Teucrium*, etc.; in others it is concave or boat-shaped, e.g. *Plectranthus, Ocimum, Becium, Orthosiphon*, etc., where it obviously serves to protect the anthers and stigma, and then the broad spreading upper lip acts as a landing-place for insect visitors. The convex upper lip of some genera, e.g. *Salvia, Stachys, Leonotis*, etc., encloses and protects the stamens and style. The lower lip of the genus *Leonotis* is small and withers soon, which is a characteristic feature of this genus.

In such highly specialised insect-pollinated flowers the stamens and style are modified and placed in such a way as to come into affective contact with the desirable visitors. There is a tendency towards the fusion of the filaments which also serves to adapt the flowers better to insect pollination. This tendency is met with in the genera *Orthosiphon* and *Syncolostemon* where the filaments of the lower pair of stamens are variably united, and in *Coleus* where they are shortly united into a closed tube above their insertion. In some of the species of *Salvia*, e.g. *S. radula*, etc., the two empty anther-thecae are slightly united along their inner lateral margins by which the highly specialised pollination mechanism in this genus is carried out very effectively. When the insect visitor presses these thecae up the two fertile ones come down simultaneously on to its back.

The pairs of stamens are usually of unequal length, and usually all bear fertile anthers except in the most advanced genera, where two stamens are reduced to staminodes, e.g. *Hoslundia*, or are altogether wanting, e.g. *Salvia*. In this latter genus the economy is carried a step further. In *S. radula*, etc., the two filaments are much reduced, the connective is elongated, and bears a single fertile anther-theca at its top end and an empty one below. Economy is carried yet further in *S. stenophylla* and others, where the lower ends of the deflexed connectives are naked. Although all these reductions make for economy and consequent advance, they do not appear to interfere with the general efficiency, which indicates that this family has reached a very high level of evolution.

The gynaeceum consists of two carpels and the ovary is four-chambered and four-lobed owing to the bending in of the carpel walls. Each chamber contains a single ovule with basal placentation. A true schizocarpic condition is obtained, which has become a constant feature of the *Labiatae* and shows the advance they have made. The stigma is usually bifid, but often it is almost entire, e.g. *Orthosiphon*, *Syncolostemon*, etc. The style is central in the *Ajugeae*, but in the remaining tribes it is gynobasic.

Variously modified nectaries are found on the disc. In many cases the disc tends to form lobes round the ovary, and thus helps in the protection of the latter.

Dioecism is met with in *Iboza* (*Moschosma*). It is considered to be a division of labour with all the advantages for cross-pollination which may be secured thereby. It adds to efficiency and is a sign of advance.

The *Labiatae* form a very natural group of the flowering plants, and the seventh largest family of flowering plants, and the third of the *Sympetalae*. The process of evolutionary differentiation has resulted in the production of 170 genera, of which 70 with 1200 species are represented in Africa. Of these, 68 genera are indigenous. In South Africa there are 27 genera with 235 species, and in Madagascar 22 genera with 95 species.

Four of the South African genera are endemic. It is quite evident that some tribes and genera are far more advanced than others; some features may have developed further than others, and no genus is therefore equally advanced in all respects. In the delimitation of the family the floral features marking progressive advance towards efficiency have been considered to trace the course of the phylogenetic history, and the probable interrelationship of the different tribes and genera.

It is quite evident that systematists were at first not concerned with evolutionary questions in the drawing up of their schemes of classification. In Engler and Prantl's Pflanzenfamilien (vol. iv) Briquet considers his tribe *Satureieae*, and especially the subtribe *Menthinae*, as the most primitive from which the other groups, except the subfamily *Ajugoideae*, have evolved. His reasons for this are given as the wide distribution of the tribe and the fact that the flowers are comparatively simple. From this we must conclude that he thought the *Labiatae* to be polyphyletic in origin. This would perhaps suggest that the *Satureieae* originated from a point somewhere near the advanced herbaceous and temperate *Boraginaceae* or the *Verbenaceae*. It must be admitted that the issue is somewhat obscured, and this is certainly due to parallelism (Arber and Parkin, 1907). However, we should bear in mind that the main evolutionary trends of the *Labiatae* were towards zygomorphy and schizocarpy, the latter for the better protection and dispersal of the seeds. These tendencies are initiated in the *Ajugeae*, and only fully developed in later advanced descendants. Thus they were probably monophyletic in origin. Another point to bear in mind, is that such a large and highly advanced family must have originated at a fairly early stage in the history of flowering plants.

Briquet's arrangement of the subfamilies more or less follows a phylogenetic order, for he takes the central and the gynobasic position of the style to be of primary importance.

LABIATAE.

Herbs or shrubs. *Stems* usually square in cross-section. *Leaves* opposite or whorled, rarely alternate, simple, exstipulate. *Flowers* zygomorphic, rarely actionomorphic, bisexual, rarely unisexual. *Calyx* campanulate, persistent. *Corolla* sympetalous, 2-lipped, rarely 1-lipped, 4–5-lobed, deciduous. *Stamens* usually 4, rarely 2 by reduction, epipetalous; anthers 2- or 1-thecous. *Ovary* superior, deeply or rarely shortly 4-lobed, 4-chambered; style central, gynbosaic, rarely not gynobasic, 2-cleft, rarely simple, ovules 1 in each chamber. *Fruit* separating into 4 dry nutlets. *Seed* without endosperm.

Key to the Tribes.

1. Style gynobasic . . . . . 2.
   Style not gynobasic . . . . . 1. AJUGEAE (Gen. 1–3).

2. Stamens all ascending; very rarely equal and erect, but then the corolla subregular and 4-lobed . . . . . 3.
   Stamens all descending; very rarely included in the corolla tube, or the flowers unisexual . . . . . 2. OCIMEAE (Gen. 4–17).
3. Stamens 4 . . . . . 4.
   Stamens 2 . . . . . 6. SALVIEAE (Gen. 27).
4. Corolla distinctly 2-lipped . . . . . 5.
   Corolla subregular, or if slightly 2-lipped then the upper lip not concave, 3. SATUREIEAE (Gen. 18–19).
5. Lower pair of stamens the longer . . . . . 5. STACHYEAE (Gen. 21–26).
   Upper pair of stamens the longer . . . . . 4. NEPETEAE (Gen. 20).

Tribe 1.—AJUGEAE: *Calyx* 5-toothed or 2-lipped and inflated. *Corolla* 1-lipped (the lower lip only) or 2-lipped with the upper lip short and usually 2-lobed. *Stamens* 4, didynamous all ascending; anthers 2-thecous. *Ovary* shortly 4-lobed or lobed to the middle; the style not gynobasic. (Gen. 1–3.)

Tribe 2.—OCIMEAE: *Calyx* subequally 5-toothed, the upper tooth often larger than the others. *Corolla* 2-lipped, rarely subregular and flowers unisexual; the lower lip usually concave or boat-shaped, the upper lip not hooded. *Stamens* 4, didynamous, rarely only 2 stamens and the posterior pair reduced to staminodes, all descending, rarely subequally spreading; anthers 1-thecous by confluence. *Ovary* 4-lobed; style gynobasic. (Gen. 4–17.)

Tribe 3.—SATUREIEAE: *Calyx* subequally 5-toothed or 2-lipped. *Corolla* subregular and 4-lobed, or 2-lipped with the lips small and flat. *Syamens* 4, equal, or the lower pair the longer, distant or ascending. *Ovary* 4-lobed; style gynobasic. (Gen. 18–19.)

Tribe 4.—NEPETEAE: *Calyx* subequally 5-toothed or slightly 2-lipped. *Corolla* 2-lipped, lips large, the upper lip concave. *Stamens* 4, didynamous, the upper pair the longer, all ascending under the upper lip of the corolla. *Ovary* 4-lobed; style gynobasic. (Gen. 20.)

Tribe 5.—STACHYEAE: *Calyx* subequally 5–10-toothed, 5–10-nerved. *Corolla* 2-lipped, the lips usually large, the upper lip hooded. *Stamens* 4, didynamous, the lower pair of stamens the longer, all ascending under the hood. *Ovary* 4-lobed; style gynobasic. (Gen. 21–26.)

Tribe 6.—SALVIEAE: *Calyx* usually 2-lipped. *Corolla* 2-lipped; lips large, the upper lip concave. *Stamens* 2 (the other 2 either reduced to staminodes or wanting) ascending under the hood; anthers with a long connective bearing 1 or 2 (one fertile and the other usually imperfect or wanting) widely separated linear thecae. *Ovary* 4-lobed; style gynobasic. (Gen. 27.)

Key to the Genera.

1. Style not gynobasic . . . . . 2.
   Style gynobasic . . . . . 4.
2. Calyx 2-lipped, inflated . . . . . 2. TINNEA Kotsch.
   Calyx not 2-lipped; equally 5-toothed . . . . . 3.
3. Corolla 1-lipped . . . . . 1. TEUCRIUM Linn.
   Corolla 2-lipped; the lower lip the larger . . . . . 3. AJUGA Linn.
4. Flowers bisexual . . . . . 5.
   Flowers unisexual; abortive ovary often present in male flowers 17. IBOZA N. E. Br.
5. Corolla subregular, 4-lobed 6
   Corolla distinctly 2-lipped 7

6. Stamens descending, upturned at the apex, included in the corolla tube
13. Endostemon N. E. Br.
Stamens erect, equal and distant, not included in the corolla tube
18. Mentha Linn.
7. Stamens all declinate; usually with the ends recurved upwards . . . 8.
Stamens all ascending, the ends usually bent downwards . . . . 9.
8. Fertile stamens 4 . . . . . 10.
Fertile stamens 2 . . . . . 16. Hoslundia Vahl.
9. Fertile stamens 4 . . . . . 20.
Fertile stamens 2 . . . . . 27. Salvia Linn.
10. Fruiting calyx with prominent transverse veins on the upper part
14. Geniosporum Wall.
Fruiting calyx without transverse veins . . . . . 11.
11. Upper pair of filaments bent like a knee, toothed or crested . . . 12.
Upper pair of filaments not toothed or crested; very rarely bent like a knee, but if so then the lower pair of filaments united . . . . . 13.
12. Upper calyx tooth separated from the remainder of the teeth by a broad ciliated or toothed space . . . . . 5. Becium Lindley.
Upper calyx tooth not separated from the remainder of the teeth by a broad space
4. Ocimum Linn.
13. Calyx teeth rigid and spine-like . . . . 10. Pycnostachys Hook.
Calyx teeth not spine-like . . . . . 14.
14. Fruiting calyx breaking away by a circular slit near the base
15. Aeolanthus Mart.
Fruiting calyx persistent . . . . . 15.
15. Lower corolla lobe (lip) saccate and abruptly deflexed in flower . 11. Hyptis Jacq.
Lower corolla lobe (lip) concave or boat-shaped, not abruptly deflexed in flower 16.
16. Filaments all shortly united into a closed tube . . . 9. Coleus Lour.
Filaments free or the lower pair variably united . . . . . 17.
17. Calyx teeth subequal; lower pair of filaments variably united
8. Syncolostemon E. Mey.
Upper calyx teeth broad; if subequal then the filaments all free . . . 18.
18. The lower corolla lip 3-partite . . . . 12. Thorncroftia N. E. Br.
The lower corolla lip not 3-partite . . . . . 19.
19. Filaments all free, entire, not ciliated . . . 7. Plectranthus L'Herit.
Lower pair of filaments united; if all free then the lower pair of filaments ciliated, or the calyx purplish, or the lateral calyx teeth bristle-like or ciliated
6. Orthosiphon Benth.
20. Upper lip of the corolla flat and erect . . . 18. Micromeria Benth.
Upper lip of the corolla distinctly concave, very rarely flat, if so then the upper pair of filaments the longer . . . . . 21.
21. Lower pair of filaments the longer . . . . . 22.
Upper pair of filaments the longer . . . . 20. Cedronella Möench.
22. Lower lip of the corolla soon withering; the upper lip much the larger
26. Leonotis R. Br.
Lower corolla lip not withering . . . . . 23.
23. Stamens included in the corolla tube . . . 25. Acratome Benth.
Stamens not included in the corolla tube . . . . . 24.
24. Corolla tube subincluded in the calyx . . . . . 25.
Corolla tube exerted from the calyx; the calyx 5-toothed; the teeth triangular
24. Stachys Linn.

25. Style equally bifid . . . . . 21. Ballota Linn.
Style unequally bifid; the posterior lobe the shorter . . . . . 26.
26. Calyx 5-toothed, 10-nerved . . . . . 23. Lasiocorys Benth.
Calyx subequally 6–10-toothed . . . . . 22. Leucas Brum.

1. Teucrum Linn.:—

1. *T. africanum* Thunb., found from British Kaffraria to George and from Graaff Reinet to Beaufort West and Richmond. 2. *T. capense* Thunb., extends from the Transvaal and Natal to the O.F.S. and to Humansdorp district. 3. *T. riparium* Hochst., found from Zululand to the Transkei.

2. Tinnea Kotschy et Payr.

1. *T. Galpini* Briq., found in the Barberton district. 2. *T. rhodesiana* S. Moore, Messina.

3. Ajuga Linn.

1. *A. Ophrydis* Burch., extends from the Transvaal and Natal to the O.F.S., and the south-eastern districts as far as Uitenhage.

4. Ocimum Linn.

1. *O. suave* Willd., found from the Transvaal through Zululand to Natal. 2. *O. simile* N. E. Br., Transvaal. 3. *O. americanum* Linn., found in the Transvaal, O.F.S., and also in S.-W. Africa. 4. *O. fruticulosum* Bruch., extends from the Transvaal to Bechuanaland and Griqualand West. 5. *O. Dinteri* Briq., S.-W. Africa.

5. Becium Lindl.

1. *B. obovatum* N. E. Br., extends from the Transvaal and Natal to the O.F.S., Basutoland, and to the Eastern Province as far as East London. 2. *B. angustifolium* N. E. Br., found in the Transvaal to Bechuanaland. 3. *B. burchellianum* N. E. Br., extends from Griqualand East to the Uitenhage district.

6. Orthosiphon Benth.

1. *O. macrophyllus* N. E. Br., Natal on the Drakensbergen. 2. *O. latidens* N. E. Br., Natal: Umboti district. 3. *O. macranthus* Gürke, extends from western Natal into the eastern O.F.S. 4. *O. foliosus* N. E. Br., Swaziland. 5. *O. transvaalensis* Schltr., Transvaal. 6. *O. labiatus* N. E. Br., Transvaal at Woodbush. 7. *O. Muddii* N. E. Br., Transvaal. 8. *O. Thorncroftii* N. E. Br., Transvaal in Barberton district. 9. *O. persimiles* N. E. Br., Barberton district, Transvaal. 10. *O. Rogersi* N. E. Br., Transvaal at Nelspruit. 11. *O. bracteosus* Baker, Delagoa Bay. 12. *O. Elliottii* Baker, Bechuanaland. 13. *O. Gerrardii* N. E. Br., Natal at Ingoma. 14. *O. stenophyllus* Gürke, extends from Natal to Pondoland. 15. *O. Rehmannii* Gürke, Houtbosch, Transvaal. 16. *O. albiflorus* N. E. Br., Transvaal. 17. *O. decipens* N. E. Br., Transvaal. 18. *O. subvelutinus* Gürke, Transvaal in Lydenburg district. 19. *O. teucriifolius* N. E. Br., found from the Transvaal and Natal to the Kingwilliamstown district. 20. *O. Pretoriae* Gürke, extends from the Transvaal and Zululand to Natal. 21. *O. Wilmsii* Gürke, found from Transvaal and Natal to Komgha. 22. *O. inconcinus* Briq., Camperdown, Natal. 23. *O. varians* N. E. Br., Komatipoort in the Transvaal. 24. *O. affinis* N. E. Br., northern Transvaal. 25. *O. Holubii* N. E. Br., along the Molopo River in eastern Bechuanaland. 26. *O. Bolusii* N. E. Br., Natal on the Drakensbergen. 27. *O. humilis* N. E. Br., Transvaal at Waterval

Onder. 28. *O. canescens* Gürke, Transvaal. 29. *O. serratus* Schltr., northern Transvaal. 30. *O. Woodii* Gürke, Natal at Zwartkop. 31. *O. australis* Vahl, Komatipoort, Transvaal.

7. PLECTRANTHUS L'Herit.

1. *P. spicatus* E. Mey., Uitenhage division. 2. *P. calycinus* Benth., extends from the Transvaal and Natal to the O.F.S. and the Transkei. 3. *P. myrianthus* Briq., Witwatersrand in the Transvaal. 4. *P. fruticosus* L'Herit., Transvaal in the Lydenburg district and from George to Caledon. 5. *P. petiolaris* E. Mey., Natal to Pondoland. 6. *P. arthropodus* Briq., Houtbosch in the Transvaal. 7. *P. floribundus* N. E. Br., extends from the Transvaal and Swaziland to Natal. 8. *P. saccatus* Benth., found from Natal to Pondoland. 9. *P. Rehmannii* Gürke, from eastern Transvaal to Natal. 10. *P. Krookii* Gürke, Griqualand East to Alexandria district. 11. *P. ciliatus* E. Mey., found from Swaziland to Kentani. 12. *P. villosus* T. Cook, Zululand. 13. *P. densiflorus* T. Cook, Mooi River, Natal, and Pietersburg, Transvaal. 14. *P. Tysoni* Gürke, from Natal to Griqualand East. 15. *P. laxiflorus* Benth., extends from the Transvaal through Natal to Pondoland. 16. *P. hylophilus* Gürke, Transvaal at Shiluvane. 17. *P. Kuntzii* Gürke, Natal at Clairmont. 18. *P. Cooperi* T. Cook, Natal at Byrne and in the eastern O.F.S. 19. *P. grandidentatus* Gürke, found from Natal to the Uitenhage district. 20. *P. coloratus* E. Mey., extends from Zululand to the Kingwilliamstown district. 21. *P. Eckloni* Benth., Kentani to Somerset East. 22. *P. Thunbergii* Benth., extends from Delagoa Bay through Griqualand East to Knysna. 23. *P. strigosus* Benth., found from Pondoland to the Alexandria district. 24. *P. parviflorus* Gürke, East London. 25. *P. Zuluensis* T. Cook, Zululand. 26. *P. Bolusii* T. Cook, found at Houtbosch, Transvaal, and in the Weenen district, Natal. 27. *P. purpuratus*, Harv., Umzinyati Fall, Natal. 28. *P. Galpinii* Schltr., northern Transvaal. 29. *P. Peglerae* T. Cook, Natal and the Transkei. 30. *P. natalensis* Gürke, extends from Zululand to Griqualand East. 31. *P. hirtus* Benth., found from Natal through the south-eastern districts to the Uitenhage district. 32. *P. nummularis* Briq., Zululand and Natal. 33. *P. neochilus* Schltr., found from the Barberton district to Natal. 34. *P. esculentus* N. E. Br., Zululand and Natal. 35. *P. pachyphyllus* Gürke, Natal. 36. *P. elegantulus* Briq., Karkloof, Natal. 37. *P. tomentosus* Benth., extends from the north-eastern districts of Transvaal to Natal. 38. *P. Woodii* Gürke, Natal, near Pinetown. 39. *P. dolichopodus* Briq., found at Karkloof, Natal, and at Komgha, also at Houtbosch, Transvaal. 40. *P. grallatus* Briq., Mount Frere, Natal. 41. *P. transvaalensis* Briq., found in Transvaal, Natal, and in the eastern O.F.S. 42. *P. Draconis* Briq., Biggarsberg, Natal. 43. *P. Dinteri* Briq., S.-W. Africa. 44. *P. otaviensis* Dtr., Otavi, S.-W. Africa. 45. *P. rupicolus* Dtr. m.s., S.-W. Africa.

8. SYNCOLOSTEMON E. Mey.

1. *S. lanceolatus* Gürke, extends from Natal to Griqualand East and into the eastern Free State. 2. *S. argenteus* N. E. Br., Zululand. 3. *S. parviflorus* E. Mey., found from Natal to Pondoland. 4. *S. concinnus* N. E. Br., Elandspruit Mountains in the Transvaal. 5. *S. ramulosus* E. Mey., Tembuland. 6. *S. rotundifolius* E. Mey., found from Natal to Pondoland. 7. *S. densiflorus* E. Mey., extends from Natal through Griqualand East to Kingwilliamstown.

9. COLEUS Lour.

1. *C. Rehmannii* Briq., Houtbosch, Transvaal. 2. *C. Pentheri* Gürke, extends from the eastern Transvaal and Natal to East London.

10. Pycnostachys Hook.

1. *P. urticifolia* Hook., eastern and northern Transvaal. 2. *P. reticulata* Benth., Transvaal at Houtbosch and in Natal. 3. *P. purpurescens* Briq., extends from the Transvaal and Natal to the O.F.S. and to Griqualand East.

11. Hyptis Jacq.

1. *H. pectinata* Poit., extends from Tropical Africa into the Transvaal.

12. Thorncroftia N. E. Br.

1. *T. longiflora* N. E. Br., found at Barberton. Endemic.

13. Endostemon N. E. Br.

1. *E. obtusifolius* N. E. Br., extends from Tropical Africa into the Transvaal and into Natal to Pondoland.

14. Geniosporum Wall.

1. *G. Angolense* Briq., extends from Tropical Africa to Transvaal and Natal.

15. Aeolanthus Mart.

1. *A. parviflorus* Benth., Natal and Pondoland. 2. *A. canescens* Gürke, extends from Transvaal and Natal on the Drakensbergen to Graaff Reinet. 3. *A. Rehmannii* Gürke, north-eastern Transvaal.

16. Hoslundia Vahl.

1. *H. decumbens* Benth., extends from Tropical Africa to Transvaal and Swaziland.

17. Iboza N. E. Br.

1. *I. riparia* N. E. Br., Transvaal and Natal. 2. *I. Galpini* N. E. Br., Barberton, Transvaal. 3. *I. Bainesii* N. E. Br., Witwatersrand. 4. *I. brevispicata* N. E. Br., near Pretoria. 5. *I. Barberae* N. E. Br., O.F.S.

18. Mentha Linn.

1. *M. longifolia* Huds., extends from Griqualand East through the south-western districts to the mouth of the Orange River. 2. *M. viridis* Linn., Humansdorp and Mosselbay. 3. *M. aquatica* Linn., from the Transvaal and Natal to the Cape Peninsula, also in the O.F.S. 4. *M. Sylvestris* Linn., Kentani. 5. *M. laxiflora* Benth., Glenelg River.

19. Micromeria Benth.

1. *M. biflora* Benth., extends from Tropical Africa to the Transvaal and to Griqualand East. 2. *M. pilosa* Benth., found from Natal to the O.F.S. and to Pondoland.

20. Cedronella Möench.

1. *C. triphylla* Möench, found from the Cape to Caledon. Introduced.

21. Ballota Linn.

1. *B. africana* Benth., extends from Queenstown through the south-western districts to Little Namaqualand.

22. Leucas Burm.

1. *L. glabrata* R. Br., extends from Tropical Africa to Delagoa Bay and Natal. 2. *L. Fleckii* Gürke, extends from Tropical Africa to Aus in S.-W. Africa. 3. *L. sexdentata* Skan., Marico district in Transvaal. 4. *L. martinicensis* R. Br., extends from Tropical Africa into the Transvaal, O.F.S., and Natal to Griqualand East. 5. *L. neuflizeana* Courb., found from Tropical Africa to Transvaal. 6. *L. altissima* Engl., S.-W. Africa. 7. *L. Dinteri* Briq., S.-W. Africa.

23. Lasiocorys Benth.

1. *L. capensis* Benth., extends from the south-western districts through the eastern districts to Natal, and from Graaff Reinet to Griqualand West and Transvaal.

24. Stachys Linn.

1. *S. Thunbergii* Benth., extends from the Cape to Knysna. 2. *S. tubulosa* MacO., found from Griqualand East to Natal. 3. *S. grandifolia* E. Mey., extends from Swellendam to Natal. 4. *S. Cooperi* Skan., Albany and Kentani. 5. *S. Bolusii* Skan., Malmesbury and Richmond. 6. *S. albiflora* N. E. Br., Natal on Drakensbergen. 7. *S. Kuntzii* Gürke, Drakensbergen between Natal and the O.F.S. 8. *S. Rehmannii* Skan., Houtbosch, Transvaal. 9. *S. malacophylla* Skan., Queenstown. 10. *S. sessilifolia* E. Mey., Pondoland. 11. *S. Galpini* Briq., extends from the Transkei into Transvaal. 12. *S. transvaalensis* Gürke, northern Transvaal. 13. *S. Rudatisii* Skan., Natal. 14. *S. parilis* N. E. Br., Natal on the Drakensbergen. 15. *S. aethiopica* Linn., extends from Clanwilliam to Natal and the Transvaal, also in Tropical Africa. 16. *S. scabrida* Skan., found from Uitenhage to the Transkei. 17. *S. Harveyi* Skan., Cape Town district. 18. *S. serrulata* Burch., extends from Clanwilliam to Knysna. 19. *S. attennuata* Skan., Worcester and Paarl. 20. *S. fruticetorum* Briq., Cape Peninsula. 21. *S. leptoclada* Briq., Natal along the Blouwkrantz River. 22. *S. flexuosa* Skan., Katberg Pass, Stockenstroom. 23. *S. cymbalaria* Briq., found from Cradock to Natal. 24. *S. subsessilis* Burch., extends from Uitenhage to Kingwilliamstown. 25. *S. priori* Skan., Algoa Bay. 26. *S. sublobata* Skan., Swellendam and Oudtshoorn. 27. *S. arvensis* Linn., Cape Peninsula; Introduced. 28. *S. nigricans* Benth., extends from Pondoland to the Transvaal. 29. *S. sessilis* Gürke, extends from Griqualand East into Basutoland and into Transvaal. 30. *S. simplex* Schltr., northern Transvaal. 31. *S. obtusifolia* MacO., found from the Kabousi River to Griqualand East and the O.F.S. 32. *S. Tysonii* Skan., Griqualand East. 33. *S. erectiuscula* Gürke, found from Natal to the Transvaal. 34. *S. humifusa* Burch., Bathurst. 35. *S. rivularis* Wood and Evans, found from Tembuland to Natal. 36. *S. tenella* Skan., Griqualand East. 37. *S. rugosa* Ait., extends from the Cape Peninsula to Namaqualand and to Graaff Reinet. 38. *S. Burchellii* Benth., Griqualand West. 39. *S. Lamarckii* Benth., found from Calvinia to Namaqualand. 40. *S. multiflora* Benth., extends from van Rhynsdorp to Namaqualand. 41. *S. flavescens* Benth., Namaqualand. 42. *S. gariepina* Benth., Namaqualand. 43. *S. degreana* Benth., extends from Queenstown to the O.F.S. 44. *S. spathulata* Burch., found from Griqualand West to the Transvaal. 45. *S. cuneata* Banks, Calvinia. 46. *S. Zeyheri* Skan., Calvinia. 47. *S. integrifolia* Vahl, Calvinia. 48. *S. hantamensis* Vatke, Calvinia. 49. *S. teres* Skan., Ceres. 50. *S. hyssopoides* Burch., extends from Uitenhage to Natal and also to Griqualand West and the O.F.S. 51. *S. caffra* E. Mey., extends from Komgha to Natal and the O.F.S. 52. *S. deserti* Benth., Little Namaqualand. 53. *S. germanica* Linn., Natal. 54. *S. linearis* Benth., Middelburg, C.P. 55. *S. pachycalymna* Briq., S.-W. Africa.

25. Acrotome Benth.

1. *A. inflata* Benth., extends from Queenstown to Bechuanaland and the Transvaal. 2. *A. pallescens* Benth. Namaqualand to S.-W. Africa. 3. *A. Thorncroftii* Skan., Barberton. 4. *A. hispida* Benth., Transvaal and Natal.

26. Leonotis R. Br.

1. *L. Leonurus* R. Br., extends from the Cape into Natal and Transvaal. 2. *L. Schinzii* Gürke, S.-W. Africa. 3. *L. Leonitis* R. Br., extends from Swellendam to Tembuland. 4. *L. microphylla* Skan., Transvaal. 5. *L. mollis* Benth., extends from Uitenhage to

the O.F.S. 6. *L. brevipes* Skan., northern Transvaal. 7. *L. latifolia* Gürke, Natal Highveld. 8. *L. Galpini* Skan., Queenstown. 9. *L. dysophylla* Benth., extends from the Transkei into the Transvaal and O.F.S. 10. *L. dubia* E. Mey., found from Uitenhage to East London. 11. *L. intermedia* Lindl., Port Elizabeth. 12. *L. laxifolia* MacO., extends from Albany to Natal. 13. *L. Westae* Skan., Port Elizabeth. 14. *L. Bachmannii* Gürke., Pondoland and Transvaal. 15. *L. hereroensis* Briq., S.-W. Africa.

27. SALVIA Linn.

1. *S. garipensis* E. Mey., Little Namaqualand. 2. *S. Dinteri* Briq., S.-W. Africa. 3. *S. Steingroeveri* Briq., S.-W. Africa. 4. *S. ecklonia* Benth., Clanwilliam. 5. *S. aurea* Linn., found from Clanwilliam to Port Alfred. 6. *S. nivea* Thunb., found from Cape Town to van Rhynsdorp. 7. *S. hastaefolia* Benth., Clanwilliam. 8. *S. africana* Linn., extends from Caledon to Malmesbury. 9. *S. dentata* Ait., extends from Calvinia to Namaqualand. 10. *S. undulata* Benth., Clanwilliam. 11. *S. paniculata* Linn., found from Clanwilliam to Namaqualand. 12. *S. albicaulis* Benth., found in the Worcester area. 13. *S. rugosa* Thunb., extends from the Cape to Namaqualand and to O.F.S., Natal, and Transvaal. 14. *S. radula* Benth., Transvaal. 15. *S. disermas* Linn., extends from Calvinia to Uniondale. 16. *S. clandestina* Linn., extends from Beaufort West to Griqualand West, the O.F.S., and Basutoland. 17. *S. Tysonii* Skan., found from Tembuland to Zululand. 18. *S. scabra* Linn., found from Uitenhage to Port Alfred. 19. S. *Galpinii* Skan., Queenstown. 20. *S. aurita* Linn., extends from Knysna to the Transvaal. 21. *S. pallidifolia* Skan., Somerset East. 22. *S. triangularis* Thunb., Uitenhage and Somerset East. 23. *S. obtusata* Thunb., found from Uitenhage to Port Alfred. 24. *S. lasiostachys* Benth., Uitenhage. 25. *S. namaensis* Schinz, S.-W. Africa. 26. *S. Burchellii* N. E. Br., found from Richmond to Victoria East. 27. *S. stenophylla* Burch., extends from Uitenhage into Natal and Transvaal, also into Griqualand West, O.F.S., and Basutoland. 28. *S. runcinata* Linn. Same distribution as No. 27. 29. *S. sisymbrifolia* Skan., extends from Natal to Transvaal. 30. *S. repens* Burch., found from Somerset East to Albert. 31. *S. monticola* Benth., extends from Queenstown into the Transkei. 32. *S. raphanifolia* Benth., Albany. 33. *S. Peglerae* Skan., East London. 34. *S. rudis* Benth., extends from Uitenhage into Natal. 35. *S. Woodii* Gürke, extends from Natal into the O.F.S. and Transvaal. 36. *S. Cooperi* Skan., extends from Griqualand East into Natal and the O.F.S. 37. *S. granitica* Hochst., Caledon. 38. *S. crispula* Benth., S.-W. Africa. 39. *S. coccinea* Juss., Queenstown. Introduced. 40. *S. Grahami* Benth., Ermelo. Introduced. 41. *S. leucantha* Cav., Pietermaritzburg. Probably introduced.

BIBLIOGRAPHY.

AITKEN, R. D.—"The Plant Succession in a type of Midland Treeveld in Natal," S.A. Journ. of Sc., vol. xviii, Nos. 3 and 4, June 1922.

ANDREWS, E. C.—"The Development and Distribution of the Leguminosae," Journ. Proc. Roy. Soc., N.S.W., 1914.

ARBER, E. A. N., and PARKIN, J.—"On the Origin of the Angiosperms," Journ. Linn. Soc., vol. xxxviii, 1907.

ARESCHONG, F.—"Der Einfluss des Klimas auf die Organisation der Pflanzen insbesondere auf die anatomische Structur des Blattes," Engler's Jahrb., vol. ii, 1882.

BENSON, M.—"The Origin of the Flowering Plants," New Phyt., vol. iii, 1904.

BENTHAM, G.—"Notes on the Classification, History, and Geographical Distribution of Compositae," Journ. Linn. Soc. (Bot.), vol. xiii, 1873.

BESSEY, C. E.—"Phylogeny and Taxonomy of the Angiosperms," Bot. Gaz., vol. xxiv, 1897.

BEWS, J. W.—The World's Grasses, London, 1929.

BEWS, J. W.—"Studies in the Ecological Evolution of the Angiosperms," New Phyt., vol. xxvi, Nos. 1–5, 1927.

BEWS, J. W.—"Plant Forms and their Evolution in South Africa," S.A. Journ. of Sc., 1924.

BEWS, J. W.—Flora of Natal and Zululand, Pietermaritzburg, 1921.

BEWS, J. W.—"The Vegetation of Natal," Ann. Natal Museum, vol. ii, p. 3, 1912.

BEWS, J. W.—"An Ecological Survey of the Midlands of Natal, with special reference to the Pietermaritzburg District," Ann. Natal Museum, vol. ii, p. 4, 1913.

BEWS, J. W.—"An Account of the Chief Types of Vegetation in South Africa, with notes on the Plant Succession," Journ. of Ecology, 1916.

BEWS, J. W.—"The Growth Forms of Natal Plants," Trans. Roy. Soc. of S. Afr., 1916.

BEWS, J. W.—"The Plant Succession in the Thorn Veld," S.A. Journ. of Sc., 1917.

BEWS, J. W.—"Plant Succession and Plant Distribution in South Africa," Ann. of Bot., vol. xxiv, 1920.

BEWS, J. W.—"The South-East African Flora: its Origin, Migrations and Evolutionary Tendencies," Ann. of Bot., vol. xxxvi, 1922.

BEWS, J. W.—"Notes on the Evolution of Plant Growth Forms," S.A. Journ. of Sc., 1924.

BEWS, J. W., and AITKEN, R. D.—"The Distribution and Ecology of the Genus *Cussonia* (Thunb.)," Union of A.S. Bot. Survey Mem. 5, 1923.

BOLUS, H.—"Sketch of the Floral Regions of South Africa," Sc. in S. Afr., 1905.

CHURCH, A. H.—Thalassiophyta and the Subaerial Transmigration, Oxford, 1919.

CLEMENTS, F. E.—"Plant Succession," Carnegie Inst. of Washington, 1916.

CLEMENTS, F. E.—"Scope and Significance of Paleo-Ecology," Proc. Paleontological Soc., Bulletin of Geol. Soc. of America, vol. xxix, 1918.

COCKANE, L.—"Observations concerning Evolution derived from Ecological Studies in New Zealand," Trans. of N.Z. Inst., 1911.

COCKANE, L.—"On the Significance of Spines in *Discaria toumatou*, Raoul," New Phyt., 1905.

DARWIN, C.—Origin of Species, London, 1859.

DAVY, J. B.—"The Suffrutescent Habit as an adaptation to Environment," Journ. of Ecol., 1922.

ENGLER and PRANTL.—Pflanzenfamilien, Teil iv, 3*a* und 3*b*.

EVANS, I. B. POLE.—"The Plantgeography of South Africa," Union of S. Afr. Official Year Book, 1918.

GROOM, P.—"The Influence of External Conditions on the Form of Leaves," Ann. Bot., vol. vii, 1893.

GUPPY, H. B.—"Plant Dispersal" (vol. ii of Observations of a Naturalist in the Pacific), 1906.

HENSLOW, G.—The Origin of Plant-structures, London, 1895.

HENSLOW, G.—The Heredity of Acquired Characters in Plants, London, 1908.

MACDOUGAL, D. T.—"Heredity and Evironic Forces," Amer. A.A.S., Chicago, 1907–1908.

MACDOUGAL, D. T.—"Influence of Aridity upon the Evolutionary Development of Plants," Plant World, vol. xii, No. 10, 1918.

MACDOUGAL, D. T.—"The Origin of Xerotophytism," Plant World, vol. xxi, No. 10, 1918.

MACDOUGAL, D. T.—"The Reactions of Plants to New Habitats," Ecology, vol. ii, No. 1, 1921.

MACFARLANE, J. M.—The Causes and Courses of Organic Evolution, New York, 1918.

PEGLER, A.—"On the Flora of Kentani," Ann. Bolus Herb., vol. xi, 1916.
PHILLIPS, E. P.—"A Contribution to the Flora of the Leribe Plateau and Environs," Ann. S. Afr. Mus., vol. ix, 1917.
SAUNDERS, E. R.—"On Carpel Polymorphism," Ann. Bot., 1925 and 1927.
SMALL, J.—"The Origin and Development of the Compositae," New Phyt., 1920.
THISTLETON-DYER, W.—"On Plant Distribution as a Field for Geographical Research," Proc. Roy. Geogr. Soc., vol. xxii, 1878.
THISTLETON-DYER, W.—Flora of Tropical Africa, vol. v, London.
THISTLETON-DYER, W.—Flora Capensis, vol. v, 1897–1900, London.
WERNHAM, H. F.—"Floral Evolution," New Phyt., *Reprint* No. 5, 1913.
WILLIS, J. C.—Flowering Plants and Ferns, Cambridge, 1919.
WILLIS, J. C.—Age and Area, Cambridge, 1922.

NIVENIA, VENT. AND *NIVENIA*, R. BR.

By N. E. Brown.

Nivenia is so well known to South African botanists as a genus of Proteaceae that it will probably surprise some of them to be told that the plants known by that generic name never had any right to it, as the following copy of the original account of the genus *Nivenia* by Robert Brown in the Transactions of the Linnean Society of London (vol. x, p. 133, published in 1810), will at once demonstrate:—

"9. NIVENIA.

Paranomus, Salisb. Parad."

The above heads a Latin description of the generic characters, and then follows:—

"This genus was established by Mr. Salisbury: his primary generic character does not at all differ from that which he has given to Mimetes; in his account of inflorescence, however, it is evident he understood the genus nearly as I have here proposed it. I should therefore have adopted his name had it appeared to me tenable; but I am disposed to believe that he will, on reconsidering the subject, see the propriety of relinquishing it."

At that period the changing of names was not infrequent and was not considered to be a disgraceful act. Indeed, the view that was often taken of the matter for a long period was that a changed name should be adopted because "Mr. A. was a better authority than Mr. B." Even in my own younger days, now over fifty years ago, I remember being told by Sir Joseph Hooker, in reply to a question of giving a certain name to some plant, that "De Candolle is the better authority of the two, so you had better follow De Candolle."

But in the case of *Nivenia*, not only did Robert Brown wilfully and without justification change a generic name that had been published three years earlier (in 1807), but his own proposed name *Nivenia* was invalid, because that name had been used two years earlier (in 1808) by Ventenat for a genus of Iridaceae, which latter therefore claims the right of priority over *Nivenia* of R. Brown.

In Flora Capensis (vol. v, pt. 2, p. 708) *Nivenia*, R. Br. is retained in

preference to *Paranomus*, Salisbury, on the plea that uniformity of nomenclature should be preserved, a plea that is surely inadmissible, especially as Otto Kuntze had long before pointed out the error and restored the name *Paranomus*, Salisb. to the genus. But in referring the species of *Nivenia* to *Paranomus* he made no investigation of them, and merely changed the names without looking at the plants, and so has added confusion to the synonymy. I therefore here again propose the adoption of the latter name for the plants now erroneously placed under *Nivenia*, taking the oldest specific names that have been given to them, according to the modern rule of nomenclature, because in his account of the genus *Paranomus* Knight (Cultivation of Proteeae, p. 67 [1809]) changed some of the older specific names adopted in the Flora Capensis and here for others, which according to modern rules are invalid. Therefore I have examined all the available material at Kew, the British Museum, and the Linnean Society, and give below the synonymy of all the species published under *Nivenia* that are not otherwise accounted for in the Flora Capensis. But with reference to the following five species—*Nivenia media* of R. Br. and *Paranomus argenteus*, *P. cumuliflorus*, *P. flabellifer*, and *P. longicaulis* of Knight—I have not seen the types. Some of them are stated to be in the Herbarium of the Linnean Society or collected by Niven, etc., but they no longer exist in that herbarium or at the British Museum, and I learn that at about the middle of the nineteenth century the Linnean Society sold some of the collections of plants then in their possession, so it is probable that these types were then disposed of. But from the descriptions, taken in conjunction with the collector's name, the locality, and the species known at that period 1807–1810, I believe it will be found that the identifications I have made are correct, although they do not always agree with those made in Flora Capensis.

In the following enumeration I have given references to only those species of which the name or reference is not to be found in the Flora Capensis. And it must be understood that Salisbury's names were published in 1807, Knight's in 1809, and those of R. Brown in 1810 (vol. x of the Trans. Linn. Soc. is dated 1811, but pt. 1, containing R. Brown's account of Proteaceae, was published in 1810). Otto Kuntze's changes were made in his Revis. Gen. Pl., p. 580 (1891).

Species of PARANOMUS, Salisb.

In the following list the letter "N" stands for the genus *Nivenia*, R. Br., and the letter "P" for *Paranomus*, Salisb.

P. bracteolaris, Knight. The type of this is at Kew. In the Flora Capensis it is confused with *N. spicata*, R. Br., from which it is

at once recognised by its different appearance and longer and glabrous style. The locality of *P. bracteolaris* is not stated.

P. candicans, O. Kuntze. Syn. *P. argenteus,* Knight; *Protea candicans,* Thunb.; *N. mollissima,* R. Br. I have seen type specimens of both the latter and find them identical.

P. concavus, O. Kuntze. Syn. *Protea concava,* Lam.; *Nivenia concava,* R. Br.

P. cumuliflorus, Knight. Syn. *P. capitatus,* O. Kuntze and *P. lagopus,* O. Kuntze, according to his synonymy; *N. capitata,* R. Br.; *Protea capitata,* Poir.

The locality "Brandt-fly's Hill," quoted by R. Brown for *N. capitata,* is doubtless meant for the hill near the hot-spring in Brand (or Brandt) Vley in Worcester Division, a region modern collectors seem to avoid, but where I believe some of the old and little-known species await rediscovery.

P. diversifolius, N. E. Br. Syn. *Sorocephalus diversifolius,* R. Br.; *Protea diversifolia,* Poir; *Soranthe diversifolia,* O. Kuntze; *N. diversifolia,* Phill. and Hutch.

The type of *S. diversifolius* is stated by R. Brown to have been collected by Niven at Goud Rivier, and that he had seen specimens of it in Herb. Banks (now in the British Museum), Herb. Lambert, and Herb. Hibbert. I have been unable to trace the specimens formerly in the latter two herbaria, but at the British Museum is a specimen labelled as having been collected by Niven at Roodezand; and as there is a Goudini River in the Roodezand area there can be little doubt that Goud is an abbreviation of Goudini that R. Brown saw on a label in Hibbert's herbarium, for Niven first went to the Cape as a collector for Hibbert, and localities are sometimes abbreviated on his labels. This Niven specimen is not named in R. Brown's handwriting, but it agrees with his description, especially as to the entire leaves being "somewhat obtuse" and the spike of about the size of a "small plum." As no other specimen of this plant can be found I propose that it should be regarded as the type specimen of *P. diversifolius.* There is, however, another specimen at the British Museum named *Sorocephalus diversifolius* which was collected by Roxburgh and is unlocalised, but it is neither quoted by R. Brown nor named in his handwriting. Roxburgh's specimen is identical with one collected on the Langeberg Mountains in Riversdale Division, *Muir* 3721, and differs from the description of *Sorocephalus diversifolius* and from Niven's specimen by having the entire leaves longer, much narrower, and very acute, and a larger spike, which is roughly about 2 inches long and $1\frac{1}{4}$ inch in diameter. I have not been able to compare the floral structure of the Roodezand and the Roxburgh specimens, but I believe them to represent

distinct species, for usually plants from the Roodezand and Riversdale areas are specifically distinct; more material from both areas is required to decide. See also under *P. longicaulis*, Knight.

P. Dregei, O. Kuntze. Syn. *N. Dregei*, Buek.; *Soranthe Dregei*, O. Kuntze.

P. flabellifer, Knight. Syn. *N. spathulata*, R. Br., excluding syn. *Protea spathulata*, Thunb.; *N. marginata*, R. Br. (I have examined the types of both R. Brown's species and find them to be identical); *P. marginatus*, O. Kuntze; *N. Muirii*, Phill. and Hutch. (founded upon a very luxuriant specimen).

P. lagopus, Salisb. Parad. Lond., vol. i, under t. 66 (1807).* Syn. *Protea lagopus*, Thunb.; *N. lagopus*, R. Br.; *P. abrotanifolius*, Knight, of which the type is at Kew. (*N. micrantha*, Schlechter, from Elim, may perhaps belong here, but for *P. lagopus*, O. Kuntze, see *P. cumuliflorus*, Knight.) The typical plant of Thunberg, according to a note made by Mr. Hutchinson in Kew Herbarium, is the same as *Herb. Norm.* 1351 from Tulbagh.

P. laxus, N. E. Br. Syn. *Nivenia laxa*, Schlechter, Matroosberg, *Marloth* 2248. This is placed, with other species, under *N. spicata*, R. Br. in Flora Capensis.

P. longicaulis, Knight. This was described from specimens collected on mountains near Gouritz River. I have not seen the type, but am inclined to think that the plant collected by Roxburgh, and by *Muir* 3721, in Riversdale Division mentioned under *P. diversifolius* may belong to *P. longicaulis*, Knight.

Since writing the above, Dr. J. Muir of Riversdale, in reply to a question asking if he knew any plant that at all agreed with the description of *Paranomus longicaulis*, Knight, has informed me as follows:—"*Paranomus longicaulis*, Knight, is probably = *Muir* 3721, found above the farm Waterval on the N. side of the Langebergen in August 1925, and named *N. diversifolia*, Phill. & Hutch. The locality is not far from the Gouritz River, which runs N. as well as S. of the Langebergen Range." This, I think, sufficiently confirms my opinion that *Muir* 3721 is *P. longicaulis*, Knight, and that it therefore should bear that name.

P. Marlothii, N. E. Br. Syn. *N. Marlothii*, Phillips, in Ann. S. Afr. Mus., vol. ix, p. 275 (1915).

Prince Albert Division, *Marloth* 2478. I have not seen this species.

P. medius, O. Kuntze. Syn. *N. media*, R. Br.

I have failed to find the type of this species, but cannot agree with Phillips and Hutchinson in considering it to be a synonym of *P. spicatus*,

* The references so marked are omitted from the Flora Capensis and from Index Kewensis.

which, in Flora Capensis, is a mixture of species. I think it probable, from the description, that the Clanwilliam plant distributed by Drège as *N. media* is correctly named: it is the same as *Herb. Norm.* 1947, which is certainly not *P. spicatus*.

P. reflexus, N. E. Br. Syn. *N. reflexa*, Phill. and Hutch.

P. sceptrum, Salisb. Parad. Lond., vol. i, under t. 66 (1807).* Syn. *P. sceptriformis*, Knight: *N. sceptrum*, R. Br.: *N. sceptrum Gustavianum*, Druce in Rep. Bot. Exchange Club Brit. Is., 1916, p. 638 (1917); *Protea sceptrum Gustavianum*, Sparm. in Akad. Handl. Stockh., 1777, p. 55, t. 1; *Protea spicata*, Andr. Bot. Rep., t. 234, not of Linn.; *Protea alopecuroides*, Lam.

Although Sparrman's name is undoubtedly the older form, it is such a cumbersome one that it appears better to adhere to the abbreviated form adopted by R. Brown rather than to return to the original double specific name.

The figure in Andrews' Botanical Repositary, quoted above, which represents the plant as having all its leaves much divided, without any that are entire, is an interesting one, because Knight (Cult. Prot., p. 69), under *P. sceptriformis*, states of it that it "was made from a plant at Clapham when it first flowered without any simple leaves, the following year it produced both 2-pinnatifid and spatulated leaves, and in 1807 the leaves on the same plant, except a few 3-fid ones, were all spatulated."

P. spathulatus, O. Kuntze. Syn. *P. adiantifolius*, Knight, of which the type is at Kew; *P. parvifolius*, O. Kuntze; *Protea spathulata*, Thunb.; *N. parvifolia*, R. Br.

Strange confusion has been made in the synonymy of this plant. For Thunberg's figure of *Protea spathulata* unquestionably represents, even to the short, conical, capitate stigma, the plant which R. Brown, Phillips and Hutchinson have named *N. parvifolia*. And with the exception that Thunberg describes the leaves as marginate, his description also agrees with the plant figured, especially as to the woolly corolla (perianth), for the perianth of the plant called *N. spathulata* in Flora Capensis is somewhat adpressed villose. R. Brown quotes Thunberg's figure under both *N. parviflora* and *N. spathulata*, but in Flora Capensis it is quoted under *N. parvifolia* with the remark "excl. his herbarium specimens and description." Yet Thunberg's specimens are not quoted, nor have I seen them, and there is no note of their comparison made in Kew Herbarium. But according to Juel (Plantae Thunbergianae, p. 269) they were seen and named at Kew as follows by Hutchinson:—

Sheet "α, *parvifolia*, Br. t. v, made from the right-hand specimen, Hutchinson!"

Sheet "β, *spathulata*, Br. Hutchinson!"

This clearly demonstrates that two species are mixed in Thunberg's herbarium, and therefore the name should be retained for the plant on Sheet *a*, which is figured, and with which the description, except as to leaves, agrees. For the other plant see *P. flabellifer.*

P. spicatus, O. Kuntze. Syn. *Leucadendron spicatum*, Berg.; *Protea spicata, Linn.*; *P. crithmifolius*, Knight, founded upon *Protea lagopus*, Andr. Bot. Rep., t. 243 (the type of which is at Kew), not of other authors; *N. spicata*, R. Br.; *N. crithmifolia*, R. Br. and of Flora Capensis; *N. Bolusii*, Gand.

The above references all belong to the true *Leucadendron spicatum*, Berg. (*Protea spicata*, Linn.), which is essentially a plant of Hottentot Holland Mountains.

The *Nivenia spicata* of Flora Capensis is a mixture of at least three or four species, only the Caledon specimens quoted belong to it; *Bolus* 4197 is a typical specimen of *P. spicatus. P. bracteolaris* and *P. laxus* are quite distinct, and I believe *P. medius*, as above indicated, to be another species mixed with *N. spicata.* Under *N. crithmifolia* I think more than one species is also included in Flora Capensis. The type of *P. crithmifolius* is identical with the Linnean type of *Protea spicata.*

Under *N. spicata, Bolus* 7863, from Elim, is also quoted, but this plant appears to me to be the same as *N. micrantha* Schlechter, also from Elim, which is placed as a synonym of *N. lagopus*, R. Br., where it may perhaps belong. There appears to be several closely related species of this alliance that require to be worked out and definitely characterised from living material.

P. tomentosus, N. E. Br. Syn. *N. tomentosa*, Phill. and Hutch.

With reference to *Nivenia*, Ventenat, the following is a revision of the genus and species.

NIVENIA, Vent.

Perennial shrublets, with branching or rarely simple stems, which become woody below. Leaves laterally flattened, linear, acute, arranged in two ranks along the stem and branches and closely imbricating at the stem-clasping base. Peduncle much flattened and acutely 2-edged, terminating in a spicate, corymbose or umbellately corymbose inflorescence. Flowers with a distinct tube and six subequal oblong lobes, and falling entirely away from the ovary as they fade, solitary or (in *N. binata*) two together, sessile within an involucre formed of two firm, entire, and subequal outer bracts and one membranous, toothed, or 2-lobed inner bract, usually much longer than the outer bracts and probably formed of two

bracts united along one margin. Stamens 3, included within or exserted from the tube, sometimes both forms occur in the same species (flowers dimorphic); anthers dorsifixed. Style slender, with 3 small, entire stigmas, included within or exserted from the tube, both forms occurring, but on separate plants, in those species that have dimorphic flowers. Ovary small, more or less obovoid and subtruncate at the top, with 8 ovules (in *N. corymbosa*) in each cell. Capsule subglobose or oblong, with 2 (or more?) seeds in each cell. Seeds (only seen in *N. corymbosa*) elongated, trigonous.—Ventenat, Decas Generum Novarum aut parum cognitorum, p. 3 (1808), not of R. Brown (1810).

Species 6, natives of South Africa, of which *N. corymbosa*, Baker is the type of the genus.

This genus is dedicated to and keeps alive the memory of James Niven, one of the early collectors of plants in South Africa, who, between 1798 and 1812, discovered and introduced into England many new species. In 1798 he went there to collect seeds and plants for Mr. George Hibbert, and afterwards for Mr. Lewis Kennedy, of the firm of Lee & Kennedy, nurserymen at Hammersmith at that period. Among the plants he discovered and introduced was *N. corymbosa*, which appears to have been raised from seed in 1803, and was figured in the Botanical Magazine at t. 896 as *Witsenia corymbosa*. A plant of it was sent by Kennedy to Ventenat as being a species of *Witsenia*, and upon this plant Ventenat founded the genus *Nivenia*. He does not mention its specific name, but his description unquestionably refers to *N. corymbosa*. Ventenat remarks that it is more nearly allied to *Aristea* than to *Witsenia*, but differs by having a many-seeded capsule. The ovary of *N. corymbosa* has about 8 seeds in each cell, but in the only capsule of it I have been able to examine I found only 2 seeds in each cell. *Nivenia*, however, clearly differs from *Aristea*, and can be instantly recognised by its shrubby habit, by its different inflorescence, by the flowers having a distinct tube, and by falling away upon fading, whereas in *Aristea* the flowers have no distinct tube, and upon fading twist spirally and persist upon the young fruit, the seeds also of *Aristea* appear to be more numerous and different in form, but of this I am unable to judge, as I have seen only those of *Nivenia corymbosa*.

It may be noted here that in Flora Capensis and in Index Kewensis the genus *Aristea* is credited to Solander, but there is no evidence in Aiton's Hortus Kewensis to show that Solander wrote any part of that book. Aiton's own statement is to the effect that he consulted and made use of Solander's notes, doubtless with Solander's permission, which does not entitle Solander to be credited as the author of genera and species he never published, and which Aiton did publish. For it appears evident from the copious notes of Solander preserved in the British Museum that they were

intended more for private use than for publication, and probably never would have been published by Solander himself.

After *Nivenia* was founded by Ventenat its history appears to be as follows. Ker in his work upon Iridaceae ignores *Nivenia* and retains the plant in the genus *Witsenia*, where it does not belong. But Salisbury (in 1812, in Transactions of the Horticultural Society of London, vol. i, p. 311) and Baker (in 1877, in Journal of the Linnean Society, Botany, vol. xvi, p. 109) and Klatt (in 1882, in Ergänzungen und Berichtigungen zu Baker's Systema Iridacearum, p. 48) all upheld the genus *Nivenia*. In 1805, however, an allied species (*N. fruticosa*) was referred by Persoon to the genus *Aristea*, and in 1880 Bentham, in Genera Plantarum (vol. iii, p. 701), took the same view and placed *Nivenia* as a synonym of *Aristea*, without proper investigation. When Baker prepared his account of South African Iridaceae for the Flora Capensis (vol. vi, pp. 48 and 54–55), he changed his opinion and adopted Bentham's view. This appears to me a retrograde step, for, as stated above, *Nivenia* can be instantly distinguished at sight from *Aristea*, and the wonder is that some South African botanist has not long ago pointed out the very obvious distinction. I therefore here propose to restore *Nivenia*, Vent. to its rightful generic rank and place under it the following species:—

Peduncle ending in a short dense spike or 1–3-flowered; leaves 1–2¾ inches long and ¾–1 line broad; flower-tube 5–7 lines long; anthers yellow or creamy.
  Outer involucral bracts 7–8 lines long, narrowly lanceolate, acute or acuminate 1. *fruticosa.*
  Outer involucral bracts 3–5 lines long, obtuse, lobes of the flower 8–9 lines long 2. *concinna.*
Peduncle branching into a compact and somewhat umbellately corymbose cluster of flowers, with 2 flowers in each involucre; flower-tube 3–3½ lines long; stamens and style blue . . . . . 6. *binata.*
Peduncle branching into a many-flowered (but not umbellately branched) corymb, with 1 flower in each involucre; leaves 1½–8 inches long and 1–2½ lines broad; outer involucral bracts 2–2½ lines long; anthers and style both apparently creamy or yellowish.
  Inner bract of the involucre exserted 3–5 lines beyond the outer; flower-tube 11–15 lines long . . . . . 3. *Stokoei.*
  Inner bract of the involucre exserted ½–1 line beyond the outer.
    Flower-tube 3–4 lines long; corymb rather compact . . . 5. *corymbosa.*
    Flower-tube 9–10 lines long; corymb somewhat lax . . . . 4. *dispar.*

1. N. fruticosa, Baker. Plant ½–1 foot or more high. Leaves ¾–3½ inches long, ¾–1¼ line broad, perhaps somewhat glaucous. Peduncle up to 1 inch long, unbranched and ending in a dense spike ¾–1 inch long. Outer involucral bracts 8–18 lines long, narrowly lanceolate, very acute or acuminate, firm, brown (dried). Inner bract 7–9 lines long, about

equalling the outer, but more membranous, acutely toothed. Flower-tube of the only flower examined, about 6 lines long, yellow ex Thunberg; lobes damaged, apparently 5–6 lines long and 2 lines broad, intense blue, according to Niven. Stamens exserted ¼ inch from the tube; anthers yellow. Style included in and shorter than the tube, with stigmas about ⅓ line long, apparently yellowish.—*N. fruticosa*, Baker in Journ. Linn. Soc. Bot., vol. xvi, p. 109. *Ixia fruticosa*, Linn. f. Suppl., p. 93; Thunb., Diss. Ixia, p. 5, t. 1; Lam., Encycl., vol. iii, p. 333; and Tableau, vol. i, p. 108, t. 31, f. 4. *Witsenia ramosa*, Thunb., Flora Capensis ed. Schult., p. 66. *W. fruticosa*, Ker in Konig and Sims' Ann., vol. i, p. 237. *W. ramosa*, Vahl, Enum. Pl., vol. ii, p. 47. *W. capitata*, Klatt in Linnaea, vol. xxxiv, p. 546. *Aristea fruticosa*, Pers., Synop. Pl., vol. i, p. 41.

Caledon Division: mountains of Nieuwe Kloof, *Burchell* 8096!. Swellendam Division: Tradouw Pass, *Bowie*! *Niven*!. Riversdale Division: summit of Kampsche Berg, *Burchell* 7100!.

The flowers of this species are probably dimorphic, but I have seen only the short-styled form.

The figure of it in Lamarck's Tableau (pl. 31, fig. 4) is very inaccurate and misleading, because it represents the flowers as solitary on slender pedicels much exceeding the leaves, which is quite unlike the true *Ixia fruticosa*, Linn. f. Had that figure been correct, it would have undoubtedly represented an undescribed species. But the artist in making that drawing has evidently drawn largely from imagination, for a photograph of Lamarck's actual type, now before me, represents the true *I. fruticosa*, Linn. f., with the peduncle and short spike much shorter than the leaves!

2. N. concinna, N. E. Br. Plant 4–8 inches high, with slender stems or branches ⅔–1 line thick, apparently arising from an underground root-stock. Leaves 1¼–2¾ inches long and ⅔–1 line broad. Peduncle 3–6 lines long, very much shorter than the terminal leaves and bearing 1–3 flowers, with pedicels below the involucre 1–1½ line long. Outer involucral bracts about 3 lines long, firm, green, with a dark brown margin at the apex. Inner bract exserted 2–2½ lines beyond the outer, submembranous, rounded at the toothed apex, brown. Flower-tube about 5–7 lines long and exserted about 2 lines beyond the inner bracts; lobes 8–9 lines long, 3–4 lines broad, oblong, obtuse, apparently deep blue. Stamens exserted ¼ inch from the tube; anthers 1¼ line long, yellowish. Style about 9–10 lines long, exserted beyond the anthers, whitish; stigmas about 1½ line long.

Caledon Division: Viljoen's Pass, *Salter* 2033!.

I suspect this is the plant of which Adamson describes the stem-structure in Trans. R. Soc. S. Afr. (vol. xiii, p. 188, 1926), under the name of *Aristea fruticosa*, with which his description does not agree.

3. N. Stokoei, N. E. Br. Plant apparently a foot or more high. Leaves

1½–4½ inches long, 1¼–2½ lines broad. Peduncles 1½–2¾ inches long, not exceeding the leaves, branching into a many-flowered corymb 2–2½ inches long and 1½–2½ inches in diameter; primary branches 4–9 lines long below their first point of branching, then usually forked and the divisions forking again or giving off flowers at intervals of 2–3 lines. Pedicels 1½–3 lines long. Outer involucral bracts 2½ lines long, green or brownish on dried specimens, with a broad blackish-brown margin. Inner bract exserted 3–5 lines beyond the outer, acute, toothed, brown. Flower-tube 11–15 lines long and exserted 7–9 lines beyond the bracts; lobes 6–6½ lines long, 2–2¼ lines broad, oblanceolate, rounded at the apex, blue. Stamens exserted about ¼ inch from the tube in the specimens seen; anthers 1¾ line long, yellowish. Style exserted 6–7 lines from the tube, slender; stigmas about ⅓ line long, yellowish.—*Aristea Stokoei*, Guthrie in Ann. Bot. Herb., vol. iv, p. 24.

Caledon Division: near mouth of Palmeit River, *Stokoe* 946!.

4. N. dispar, N. E. Br. Plant similar to *N. corymbosa*. Leaves 3½–6 inches long, 1½–2 lines broad. Peduncle 2½ or more inches long, raising the corymb well above the leaves. Corymb 3–4 inches long and 3 inches in diameter, much more lax than in *N. corymbosa*, main branches 2–4 inches long, branching again and the branchlets bearing 2–5 flowers at intervals of 2–3 lines, sometimes with 2–3 flowers at a node. Pedicels 2½–4 lines long. Outer involucral bracts about 2–2¼ lines long, obtuse, blackish-brown (dried). Inner bract about 3 lines long, brown. Flower-tube 8–10 lines long and about 6 lines longer than the bracts; lobes about 6 lines long and 2½ lines broad, oblong, rounded at the apex. Stamens exserted 4–5 lines from the tube in the only form of flower seen; anthers 1–1¼ line long, yellow or creamy. Style 8–9 lines long, included in the tube; stigmas very minute.

South Africa, without precise locality, *Zeyher*!.

The more lax corymb and much longer flower-tube readily distinguish this from *N. corymbosa*, but I have not seen the form of it with exserted style and included stamens, which no doubt exists.

5. N. corymbosa, Baker. Plant stated to attain a height of from 2–4 feet. Leaves 2–8 inches long, 1–2½ lines broad. Peduncle 2–4½ inches long, branching into a rather compact corymb 1½–2½ inches long and 1–3½ inches in diameter, with the main branches 5–20 lines long. Pedicels mostly 1–2 lines long, but some in the forkings of the branches 3–5 lines long. Outer involucral bracts 2–2½ lines long, obtusely rounded to subacute at the apex, brown; inner bract 2½–3 lines long, membranous, shortly and obtusely bifid at the apex, brown. Flower-tube 3–4 lines long, blue; lobes 3½–5 lines long, 1½–2 lines broad elliptic-oblong, rounded at the apex, blue, with a small whitish spot at the base of each. Stamens exserted

from the tube in one form of flower, or included in it with the anthers closing its mouth in another form of flower; anthers ½–¾ line long, light yellow. Style included in the tube or 6–7 lines long and exserted from it in the different forms of flowers, pale bluish; stigmas ¼–¾ line long.—*N. corymbosa*, Baker in Journ. Linn. Soc. Bot., vol. xvi, p. 109 (1877). *N. stylosa*, Salisb. and *N. filamentosa*, Salisb. in Trans. Hort. Soc. Lond., vol. i, p. 311 (1812). *Witsenia corymbosa*, Gawl. (Ker) in Bot. Mag., t. 895 (1805); Smith, Exotic Botany, vol. ii, p. 17, t. 68 (1805); Redoute, Lil., vol. viii, t. 453 (1816); Loddiges, Bot. Cab., t. 254 (1818); Geel, Sert. Bot., Class 3 (1828); Reichenb. Fl. Exot., vol. i, t. 24 (1834); Paxton, Mag. Bot., vol. iii, p. 269, with fig. (1836); Maund, Botanist, vol. v, t. 202 (1841); Hortic. Univers., vol. vii, p. 230 (1846); Journ. Hort., vol. lxii, t. 192 (1879); Garden, vol. lxxii, p. 375. *Aristea corymbosa*, Gard. Chron., vol. xlii, p. 164 (1907); Journ. Hort., vol. lvii, p. 592 (1908); Garden, vol. lxxx, p. 441; Adamson in Trans. R. Soc. S. Afr., vol. xiii, p. 178, stem structure.

All the above-quoted figures represent the long-styled form of the plant, but in Mordant de Lawnay (Herb. General de Amat., vol. iv, t. 235, 1820) is a figure that is repeated in Drapiez (Herb. Amat. Fl., vol. vi, t. 433, 1833), which represents the short-styled form of this species, with exserted stamens, which Salisbury named *N. filamentosa*.

Tulbagh Division: among rocks near Tulbagh Waterfall, *Zeyher*!; near Tulbagh, *Cooper* 3175!; between New Kloof and Elands Kloof, *Drège* 1986!; near Baines Kloof, *Bolus* 4068!.

N. corymbosa was discovered by James Niven, who sent seeds of it in 1803 to England to Mr. George Hibbert and to Kennedy, a nurseryman at Hammersmith. Formerly it was widely cultivated in Europe, but at present it is seldom seen although a very ornamental plant, flowering freely from October to December. In Devonshire it has proved to be hardy.

6. N. binata, Klatt. Plant 1–2½ feet high. Leaves 3–4 inches long, 1½–2 lines broad, somewhat glaucous green. Peduncle about 2 inches long, 1¼ line broad, apparently somewhat glaucous, terminating in a compact umbel-like cluster 1½–2 inches in diameter, the primary divisions very short and only 1–3½ lines long, each with three to several pedicels 3–6 lines long, bearing a pair of sessile flowers within the involucre, developing successively. Outer involucral bracts 2½ lines long, obtuse, apparently dark brown, fading to green at the base, enclosing 2 flowers. Inner bracts about 3–3½ lines long, crumpled, dark brown. Flower-tube 3–3½ lines long; lobes 4 lines long and 1½–1¾ line broad, oblong, obtuse, or rounded at the apex, blue. Stamens included in the tube or exserted about 2 lines from it, with blue filaments; anthers ¾–1 line long, blue. Style included in the tube or exserted 4 lines from it, blue; stigmas very minute, about

$\frac{1}{3}$ line long in the specimen examined.—*N. binata*, Klatt, Ergänz., p. 48. *Witsenia ramosa*, Klatt in Linnaea, vol. xxxiv, p. 547 (1866), not of Vahl, and excluding syn. *Ixia fruticosa*, Thunb. *Aristea lignosa*, Adamson in Trans. Roy. Soc. S. Afr., vol. xix, p. 373 (1931).

Oudtshoorn Division: Great Zwartberg, *Drège* 2184! Ladismith Division: Seven Weeks Poort, *Adamson*, and *Levyns* 2443 ex Adamson.

NEW AND NOTEWORTHY SOUTH AFRICAN CHAROPHYTA.*

II.

By James Groves † and Edith L. Stephens.

(With Plates XIII–XVI.)

Since the publication of the first instalment of our notes in 1926, in Vol. XIII of these Transactions, a considerable number of specimens have been collected in various districts. These include some new species, several of which are now described and figured. Many of the specimens represent important extensions of the range of species already recognised as South African, while a few of them belong to species not hitherto known from the area. There is good reason to suppose that, when fully explored, South Africa * will prove one of the richest parts of the world for this group of plants, and the authors would much appreciate specimens from anywhere in Africa south of the Equator.

A large collection of Charophyta was made by Mr. T. B. Blow, in 1924, in various parts of Madagascar, which island comes within the scope of our projected Charophyte-Flora. These formed the subject of a separate memoir in the Journal of the Linnean Society (Botany), vol. xlviii (1928), in which several new species are described and figured. Two more new species from Madagascar, collected by Hildebrandt in 1879–80, are described in the present paper.

From the following districts we have up to the present received either no specimens at all or very few:—

IX. Kenya.
X. Uganda.
XI. Belgian Congo.
XII. French Equatorial Africa.
XIV. St. Helena and other western islands.

* "South Africa" in this series of papers is used to include all of the southern half of the continent, from the equator southwards.

† This paper was ready for the Press (except for the description of the plates) before the death of Mr. Groves in March of this year. Mr. Groves had been for some years the chief living authority on the Charophyta, and the extension of our knowledge of the South African species represented by these notes has only been possible through the great privilege of collaboration with him. The series thus initiated will be continued with the kind co-operation of Mr. G. O. Allen, who is in touch with the British Museum and Kew collections, and whom Mr. Groves regarded as his successor in the investigation of this group.—E. L. S.

We hope that botanists who have the opportunity of visiting any of these parts will endeavour to collect Charophyta. The second author will be pleased to supply materials and instructions for collecting, and arrange for the postage of specimens. (Address to the Botanical Department, University of Cape Town.)

Specimens preserved in about 2 per cent. formalin are the most satisfactory for determination, and are fairly easy to deal with when moving about. Good fruiting pieces should be secured if possible, and, in the case of dioecious specimens, portions showing the reproductive organs of plants of both sexes. On the rooting portion, usually submerged in the mud, "bulbils" are frequently to be found, and these sometimes afford valuable distinctive characters. When practicable, dried specimens in addition to those in fluid are very desirable, to show stature and habit. In preparing specimens for drying, especially in the case of Nitellas, they should be well washed, freed from algae and other extraneous matter, and floated out on paper in the same manner as seaweeds. They should then be covered over with pieces of thin unstarched and undressed linen, calico, or cotton material, such as old handkerchiefs (or, in the case of species which have their fruiting parts enveloped in jelly, with waxed paper), to prevent their adhering to the drying-paper above. They are then pressed and dried in the usual manner between sheets of drying-paper or old newspapers.

As explained in the first instalment of our notes, the measurements of fruits and other parts given in the descriptions should be regarded as approximating to the average. It may well happen that examples will be found exceeding or falling short of such measurements. To avoid a possible ambiguity, it should be explained that the term "dactyl" is applied to all ultimate rays, and so may also be alluded to as "secondary," "tertiary," "quaternary," or "quinary" rays, as the case may be, in the descriptions of the new species.

We have not thought it worth while to give the altitudes at which the plants were collected, as, with Charophytes, except when found in high mountain lakes, the altitude does not appear to be of significance.

Our best thanks are due to the many friends and correspondents who have favoured us with specimens. The work of collecting has been facilitated by a grant from the Staff Research fund of the University of Cape Town towards the travelling expenses of the second author, and by a grant from the Carnegie Corporation, through the Research Grant Board of South Africa, towards the cost of the collecting materials used in these investigations.

We are much indebted to Miss Mary Groves for her beautiful drawings of the species illustrated, and to the Rev. Canon Bullock-Webster for

allowing his delicate drawings of the oospore-membranes to be added to the plates. These have been admirably reproduced by Messrs. Whittingham & Griggs.

Nitella Knightiae, sp. nov. (Plate XIII, figs. 9–15.)

Homoeoclema, anarthrodactyla, semel furcata, acuminata, coronula persistente, gloeocephala, heteromorpha, dioecia. Ramuli verticillorum sterilium plerumque 5–6, *longissimi ; radii primarii quam secundarii magis longiores ; radii secundarii (dactyli)* 2–3 *inaequales, aut frequenter solitarii, valde acuminati. Verticilli fertiles plurimi in capitulis congesti, nube gelatinoso dense circumfusa ; ramuli* 7–8 *; radii primarii brevissimi, secundarii* 2–4, *quam primarii terque ad sexties longiores, valde acuminati. Oogonia saepe geminata ; oosporae membrana tuberculis conicis acutis ornata.*

Dioecious. Stem of medium thickness (diameter c. 500 μ). Branchlets once-forked. Sterile whorls large, distant, spreading, the branchlets, usually 5–6, exceeding the clusters of fertile whorls, the primary rays twice or more the length of the secondary; the secondary (dactyls) 2–3, unequal, or frequently solitary, always 1-celled, very acuminate, the cell-wall much thickened at the apex.

Fertile whorls for the most part crowded into rather small, compact, often almost spherical heads, sometimes interrupted below, enveloped in a dense cloud of mucus; branchlets 7–8, primary ray very short, secondary rays (dactyls) 2–4, 3–6 times as long as the primary, very acuminate.

Oogonia solitary, or geminate, occasionally three together, c. 700 μ long, 550 μ broad; spiral-cells showing about 9 convolutions, not swelling at the apex; coronula persistent, c. 70 μ broad, 50 μ high; oospore dark brown, c. 400–525 μ long, 375–500 μ broad, 250–300 μ thick, showing about 8 thin, firm, flanged and crested ridges; membrane granulate, with scattered, acute, conical tubercles.

Antheridia → c. 750 μ in diameter.

IV. Southern Rhodesia. Cleveland Dam, Salisbury, Dr. Margery Knight, M. E. Blenkiron, and E. L. S., 30th June and 1st July 1927. E. L. S. 231; Moss 17035–6.

A medium-sized to rather large plant, conspicuously heteromorphous, the branchlets of the distant sterile and occasional transitional fertile whorls being long and spreading, in contrast to the abbreviated stem-internodes and very short branchlets of the dense fertile heads. It is much unlike the two other gloeocephalous members of the group, the American *N. cernua*, Braun (dioecious) and *N. praelonga*, Braun (monoecious), both of which have clusters of tiny dactyls on the sterile branchlets, besides presenting other points of difference. The specific name commemorates the first visit to S. Africa of Dr. Margery Knight, the authority on Manx seaweeds and one of the discoverers of this plant.

N. conifera, sp. nov. (Plate XIV, figs. 7–11.)

Homoeoclema, anarthrodactyla, gymnocephala, valde heteromorpha, dioecia. Caulis modice crassus. Ramuli verticillorum sterilium semel vel bis furcati, radiis primariis multo elongatis, secundariis et tertiariis brevissimis. Dactyli plerumque 2, *erecti*

inaequales. Verticilli fertiles in capitulis densis elongatis congestis, ramulis brevissimis, per partis ter-, et nonnunquam quater-furcati. Oogonia celluliss piralibus ad apicem paulum tumidis. Membrana oosporae tuberculis sparsis bene evolutis constrata.

Dioecious. Stem moderately stout, c. 1000 μ in diameter. Sterile whorls of 8–9 branchlets, once- or twice-forked; primary rays very long, secondary and tertiary very short, dactyls conical, acute, almost erect, usually two, with sometimes a rudimentary third. Fertile whorls disposed in long cone-like heads, the ♀ more densely crowded than the ♂. Branchlets of the ♀ twice, and in part thrice, forked, with occasionally a fourth furcation; primary ray very short, secondary rays 5–6, of which 4–5 are lateral and sterile, elongated and producing at their apex 1–3 dactyls, while the central ray is very short, at its apex 4–6 tertiary rays, bearing 1–3 dactyls. Fertile branchlets of the ♂ shorter and with less numerous rays.

Oogonia solitary, usually produced only at the distal node of the central secondary ray, c. 575–625 μ (excluding coronula) long, 400–450 μ broad; spiral-cells showing about 10 convolutions, somewhat tumid at their apex; coronula persistent, c. 30 μ high, 65 μ broad. Oospore c. 425–450 μ long, 375–400 μ broad, becoming wine-red, showing about 8 very thin inconspicuous ridges, terminating in a decided crest; membrane with strong well-developed scattered tubercles.

Antheridia c. 1000 μ in diameter produced at the first and second branchlet-node.

I. i. CAPE. Malmesbury div.: roadside pools near Mamre Road station, Oct. 1925 and Nov. 1931, E. L. S. 221, 222, 351.

A rather large plant attaining a height of about 40 cm. The sterile whorls are large, with branchlets → c. 6 cm. long, presenting a marked contrast to the fertile whorls which have extremely short branchlets, arranged in particularly neat elongated fir-cone-like heads (about 4 mm. in diameter); hence the name.

The outstanding features are: the strongly heteromorphous character; the cone-like fertile heads, with peculiarly forked branchlets, the small unequal dactyls, usually in pairs and directed upwards, or very slightly divergent; the swollen tips of the spiral-cells, and the distinctive decoration of the oospore-membrane. The sculpturing of the antheridium-plates is exceptionally deep, adding greatly to the beauty of those delicate structures.

The persistent coronula in conjunction with spiral-cells with tumid tips is unusual, the latter character being associated generally with a deciduous coronula. When, as in a number of species, the tips of the spiral-cells are swollen, leaving a larger aperture between them, coupled with a deciduous coronula, it may be fairly conjectured that the object is to afford a central channel for the antherozoids, instead of a fissure at the neck. In the present species such a channel would be closed by the persistent coronula.

N. conifera bears a slight resemblance to some forms of *N. Dregeana*, but among other points of difference, the latter species has the dactyls in

threes or fives, and conspicuously divergent, and the decoration of the oospore membrane is reticulate.

N. axillocarpa, sp. nov. (Plate XIII, figs. 1–8.)

Homoeclema, arthrodactyla (constanter bicellulata), conoteles, furcata, gymnocephala, dioecia, heteromorpha. Caulis crassus. Ramuli verticillorum plerumque semel-, interdum bis-, furcati; radiis primariis multo elongatis, dactylis brevibus, cristam parvam formantibus; verticilli fertiles ramulis brevissimis, primo in capitulis dense congestis, deinde magis elongatis, postremo infra multo interruptis. Gametangia ad nodos liberos et in axillibus ramulorum sita. Oogonia solitaria. Membrana oosporae subtiliter et regulariter granulata.

Dioecious. Stem stout, c. 1200 μ in diameter, much branched. Sterile whorls of 5–6 moderately long branchlets, once- and sometimes twice-forked, consisting usually of a long (→ 30 mm.) primary ray with a node giving rise to a group of very short dactyls of unequal size; primary ray sometimes rather shorter, the node giving rise to several dactyls and to a single, or occasionally to two secondary rays, bearing a group of dactyls. Fertile whorls of 6 very short branchlets in dense heads, which become elongated, and ultimately much interrupted below, and are often branched; branchlets of the ♀ with two free nodes, the lower usually giving rise to some dactyls, and one or two secondary rays, the upper to a group of about 5 unequal dactyls, the central longer than the others; branchlets of the ♂ usually with a single node giving rise to 4–5 very short unequal divergent dactyls surrounding the antheridium, sometimes 1–2 branchlets in a whorl with two nodes, the lowest giving rise to some dactyls and one secondary ray surmounted by 4–5 dactyls. Dactyls always 2-celled, the lower cell tapering from the base, or sometimes swollen at the middle, the apex corresponding in diameter with the base of the upper, the latter usually rather long and tapering to a sharp point.

Oogonia solitary, produced at the first node, occasionally at the second node, and often in the axils of the branchlets, c. 500 μ long, 400 μ broad, spiral-cells showing about 7 convolutions; coronula persistent, c. 20 μ high, 50 μ broad; oospore dull apricot-yellow, c. 350 μ long, 300 μ broad, 250 μ thick, showing about 6 firm narrowly flanged ridges; membrane very finely and regularly granulate. Antheridia produced at the free nodes as well as in the axils of the branchlets, also sometimes on minute secondary branchlets originating in the axils of the normal branchlets.

VII. Portuguese East Africa. Lakelets near Nyamfunwini and Masiyeni, Chongoene, Gaza, 1924, E. Dora Earthy (E. L. S. 196) and various subsequent dates; 4th and 26th June 1928, E. D. E. and E. L. S. (E. L. S. 283, 288).

A rather large, stout, firm plant, about 12–18 inches high, the branches sometimes growing downwards and rooting in the mud, in this respect resembling the European *N. translucens*, as also in the varnished appearance of the stem and branchlets when dried. The sterile branchlets are almost as thick as the stem. It is a well-marked species, the outstanding features being (1) the frequent presence of oogonia and antheridia in the base of the whorls, in the axils of the branchlets (a rare condition in Nitella), and sometimes, in the same position, minute accessory branchlets bearing

antheridia; (2) the markedly heteromorphous character, the sterile whorls with fairly long, the fertile with very short branchlets forming dense heads (often branched), the internodes of which ultimately lengthen considerably, forming long interrupted spikes. In no case have we observed accessory branchlets below the normal whorls, as is usual in the Heteroclemae, and the occasional presence of some above in the ♂ plant does not, we think, justify its inclusion in that section.

We are much indebted to Miss Earthy, who discovered the plant, for collecting it on a number of occasions, enabling us to study it in various stages of growth.

N. ogivalis, sp. nov. (Plate XVI, figs. 11–14.)

Homoeclema, arthrodactyla, conoteles, flabellata, macrodactyla, gymnocephala, monoecia. Dactyli constanter bicellulati; cellula inferior sursum subito fastigata, apice valde angustato; cellula superior angusta valde acuta. Oogonia solitaria. Oospora aureo-flava; membrana nodoso-reticulata.

Monoecious. Stem rather slender, diameter c. 400 μ. Whorls of 5–6 branchlets, 2–3 times forked, the rays not much diminishing successively in diameter. Branchlets and rays often of very unequal length. Primary rays about one-third to one-half the length of the branchlet. Secondary rays 3–4, the node often giving rise to a small shoot; tertiary rays 2–4, often 1–2 again forked; quaternary 2–4. Dactyls usually unequal in length, uniformly 2-celled; when well-developed, the lower cell narrowed into a distinct neck, which, with the very narrow apical cell (c. 75–90 μ long, 35–40 μ broad at base), forms a pronounced mucro. Gametangia produced at the first and second, and occasionally at the third node, often both ♀ and ♂ together. Oogonia solitary, c. 425 μ long (excluding coronula), 375 μ broad; spiral-cells showing about 8 convolutions; coronula c. 40–50 μ high, 50–70 μ broad. Oospores golden-yellow, broadly ellipsoid, c. 280 μ long, 240 μ broad, 200 μ thick, showing 6–7 flanged ridges, but with an inconspicuous crest; membrane irregularly nodose-reticulate, about 10 meshes across the fossulae. Antheridia c. 275 μ in diameter.

XV. Madagascar. Beravi interior: Tunpel des Ansussa-Baches, July 1879, J. M. Hildebrandt (Fl. v. Madagascar, No. 3067). Specimens at the British Museum, Kew, Paris, and Berlin.

The material available was unfortunately badly dried, but as far as can be made out, it is a medium-sized plant with the habit of *N. mucronata*, to which species it is nearly allied. The outstanding distinctive features would seem to be the remarkable shape of the apex of the lower cell of the dactyls, the extremely narrow upper cell, the golden-yellow colour of the ripe oospore, and its smaller size, and the frequent production of a shoot at the first node of the branchlets. The name *ogivalis* has been given on account of the resemblance of the outline of the apex of the dactyls to that of the ogee arch.

N. heteroteles, sp. nov. (Plate XVI, figs. 9 and 10.)

Homoeoclema, arthrodactyla (bi-tri-cellulata), flabellata, macrodactyla, gymnocephala, monoecia. Cellula superior dactylorum conformatione insolenter variabilis, nunc brevi-conica, nunc elongato-conica, quandoque cylindrata apiculata, ad basem contracta; cellula inferior plerumque apice rotundata. Dactyli raro unicellulati apiculati. Oogonia saepe geminata. Oospora matura saturate brunnea; membrana subtiliter et regulariter reticulata.

Monoecious. Stem moderately stout. Whorls of 6–8 branchlets, 2–3 times forked. Primary rays less than half the length of the branchlets. Secondary rays usually 4, tertiary 3. Dactyls 2–3-celled, the penultimate cell rounded at the apex, the upper cell extremely variable in size and shape, sometimes small, short, and conical, much narrower than the lower, sometimes large and conical, nearly as broad as the lower, sometimes cylindrical-apiculate and quite as broad, often contracted at the base; rarely one dactyl is 1-celled cylindrical-apiculate. Oogonia produced at the second and third branchlet-nodes, frequently geminate, about 500 μ long (excluding coronula), 375 μ broad; coronula persistent, 30 μ high, 50 μ broad; spiral-cells showing about 9 convolutions. Oospores dark brown, nearly round, c. 300–325 μ long, 300 μ broad, 200 μ thick, showing about 8 flanged ridges terminating in a well-marked crest; membrane finely and regularly reticulate, about 15 meshes across the fossula. Antheridia produced at the first and second branchlet-nodes, c. 375 μ in diameter.

XV. Madagascar. Imerina, July 1880, J. M. Hildebrandt (Flora v. Madagascar, No. 3525). Specimens at the British Museum, Kew, Paris, and Berlin.

As in the case of *N. ogivalis*, the specimens are not well dried, but the plant is apparently of medium size, and resembles in habit *N. mucronata*, to which species it is evidently nearly allied. It differs in having usually more numerous branchlets in a whorl, and in the extraordinarily variable size and shape of the ultimate cells of the dactyls as well as having occasionally some dactyls only 1-celled.

N. Duthieae, sp. nov. (Plate XIV, figs. 12–19.)

Homoeoclema, arthrodactyla, conoteles, flabellata, gymnocephala, saepe brachydactyla, monoecia. Ramuli verticillorum 6, bis- et partim ter-furcati, dactyli inaequales, plerumque bicellulati, sed interdum tricellulati. Gametangia ad nodum primum et secundum posita. Membrana oosporae nodoso-reticulata.

Monoecious. Stem → c. 600 μ in diameter. Branchlets 6 in a whorl, twice and in part thrice furcate, the primary ray about half the length of the branchlet, secondary rays 4–5, tertiary 3–4, quaternary 2–3. Dactyls unequal, sometimes very short, usually 2-, occasionally 3-celled; lower cell about 75–125 μ thick, tapering above, upper cell very small, c. 40–75 μ long, 20–30 μ thick at base. Gametangia at first and second free nodes. Oogonia solitary, or two to four together, c. 350–375 μ long, 300–325 μ broad; coronula persistent, c. 90 μ broad, 60 μ high. Oospore warm chestnut-brown, becoming much darker, c. 250 μ long, 200 μ broad, 150 μ thick, showing 5–7 firm low ridges; membrane strongly nodose-reticulate. Antheridia produced at all free nodes, diameter → c. 600 μ.

IV. Southern Rhodesia. Livingstone Island, Victoria Falls, growing on mud on ledges of rock, constantly wetted with spray, July 1916, A. V. Duthie (E. L. S. 109); Rain Forest, Victoria Falls, February 1927, J. G. Wright (E. L. S. 230); same locality July 1927, G. E. Pickford and E. L. S. (E. L. S. 234).

The original specimens collected by Miss Duthie belong to a dwarf-tufted form, due no doubt to habitat. No. 234 is a slender rather lax form running up to about 20 cm. in height, with distant whorls measuring → about 2 cm. across. Nos. 230 and 234 are definitely brachydactylous, the dactyls very divergent, in these respects differing from No. 109. The number of oogonia varies considerably; the whorl of No. 234 shown on the plate (fig. 17) is particularly prolific.

N. Duthieae differs from all the other gymnocephalous members of the group in the character of its reticulate oospore-membrane, and does not appear to be closely related to any of them.

N. habrocoma, sp. nov. (Plate XIV, figs. 1–6.)

Homoeoclema, arthrodactyla (semper bicellulata), conoteles, flabellata, gymnocephala, macrodactyla, monoecia. Ramuli verticillorum 6, bis- et partim ter-furcati, dactyli subaequales. Radius secundarius centralis ad furcam primam productus. Gametangia ad furcam secundum et tertium posita. Membrana oosporae subtiliter granulata.

Monoecious. Stem slender, c. 200 μ in diameter. Branchlets 6 in a whorl, twice and in part thrice furcate, the primary ray about five-eighths to two-thirds the length of the branchlet, secondary rays 5–7 (one central), tertiary 4–6, quaternary 4–5. Dactyls ± equal in length, uniformly 2-celled, 30–40 μ in diameter, the lower cell narrowed somewhat at the apex, which is not much broader than the upper, upper cell long-conical, c. 100–110 μ long, 25–30 μ broad at the base. Gametangia at second and third free branchlet nodes. Oogonia solitary, c. 300 μ long, 250 μ broad, spiral-cells showing about 9 convolutions; coronula persistent, c. 40–45 μ broad, 25–35 μ high. Oospore warm brown, c. 200 μ long, 175 μ broad, 110 μ thick, showing about 7 low inconspicuous ridges; membrane finely and faintly granulate. Antheridia c. 175 μ in diameter.

I. iv. Transvaal. In small quantity in pan, Belfast, Nov. 1909, E. M. Doidge (1135*a*).

A slender, delicate plant, probably not more than 15–20 cm. high, with the habit of a very lax form of *N. tenuissima*, the whorls becoming distant, agreeing with that species in having six branchlets, and the first branchlet-node sterile, but distinguished by the branchlets being less frequently forked, the dactyls shorter, less rigid, and more divergent, and by the entirely different decoration of the oospore membrane. It differs from *N. batrachosperma* in having less numerous branchlets, having a central secondary ray, having the first branchlet-node sterile, and having low ridges to the oospore, in contrast to the broadly flanged sides in *N. batracho-*

sperma. Dr. Doidge is to be congratulated in having obtained this third new species from the same gathering as the original specimens of *N. divaricata* and *N. Doidgeae*.

N. plumosa, Braun, Characeen Afrika's, Monatsb. K. Akad. Wiss. Berl. for 1867 (1868), p. 891. Braun and Nordstedt, Fragmente, pl. vi, fig. 154*a*, *b*. (Plate XV, figs. 6–9.)

The only figures of this beautiful and remarkable species being those in the Fragmente cited above, which consist of small portions of the plant, we have thought it desirable to include an illustration of the plant full-size, as well as some magnifications, including Canon Bullock-Webster's admirable drawing of the oospore-membrane.

N. struthioptila, sp. nov. (Plate XV, figs. 1–5.)

Heteroclema, arthrodactyla (pluricellulata), conoteles, gymnocephala, valde heteromorpha, dioecia. Verticilli superiores ramulorum ordine triplice constituti; ramuli normaliter semel furcati, radiis primariis brevissimis, secundariis (dactylis) elongatis, 4–5-cellulatis, cellula ultima abbreviata conica acuta. Oogonia aggregata; coronula persistens; oospora contorta, membrana subtiliter granulata, cum corporis elongatis sparsis superposita.

Dioecious. Stem rather slender, diameter c. 500 μ. Whorls of the upper part of the plant consisting of three circles, one of primary branchlets, two of secondary, one of the latter being above and the other below the primary; lowest whorls often of only two circles. Branchlets usually six in a circle, unequal in length, in the lowest whorls simple, in the rest once-forked, with very occasionally a second sterile forking. Primary branchlets with a short primary ray, sometimes extremely short, less than one-twentieth the length of the branchlet, and very long secondary rays, one prolonged into a whip-like point. Secondary branchlets usually very short. Dactyls 3–4-, sometimes 3-, and in the case of a second forking, some even only 2-celled, the cells gradually decreasing in length, the ultimate cell conical, sometimes very short, the penultimate often conspicuously narrower than that below it. Oogonia for the most part on the secondary branchlets, usually in clusters of 3–4, 375–500 μ long, 300–350 μ broad, showing 9–10 convolutions. Coronula persistent, c. 40 μ high, 50 μ broad. Oospore golden-brown, becoming almost black, c. 325–375 μ long, 275–300 μ broad, 175 μ thick, showing 7–8 ridges (often terminating in a distinct crest), conspicuously flattened and dextrally contorted; membrane finely granulate with large irregular $\pm$ elongated projections. Antheridium c. 500–575 μ in diameter.

I. i. Cape. Ceres div.: Vlei (used as dam) on Simpson's Farm, S.W. edge of Karroo, opposite Matroosberg, Sept. 1924, E. L. S. 169; small vlei at Bokke R. on N. side of Matroosberg, Sept. 1924, E. L. S. 170; vleis in vlakte at foot of N. slope of Hex R. mountains, half-way between Touws R. and Ceres, Oct. 1924, E. L. S. 171. All these localities are in the same district, within a couple of hours' walk.

A rather small plant, the specimens collected being about 20 cm. high; the sterile branchlets very long and slender. Remarkably distinct, the

outstanding features being: the usually single forking of the branchlets; the great disparity between sterile and fertile ones; the fertile branchlets very short, forming small dense heads; the many-celled dactyls; the much-elongated dactyls of the sterile branchlets; the usually clustered oogonia; the greater fertility of secondary than primary branchlets; the curious contortion of the oospores; and the distinctive decoration of their membrane. The most noteworthy character is the torsion of the oospore, which we have not observed in any other species. At first sight the impression one receives is that this may be due to a malformation, but the examination of a large number of oospores from each gathering proved it to be fairly uniform in degree; moreover, germinated oospores have been observed with the torsion clearly visible.

Whereas in the heteroclemous species generally the gametangia are for the most part produced on the primary branchlets, the secondary being often sterile, in the present species the primary branchlets are often sterile, or bear a solitary oogonium, while the secondary are fertile, with the fruits clustered. The branchlets bear a close resemblance to those of the European Tolypella. The specific name is a tribute to the graceful feathery appearance of the plant when growing, suggesting an ostrich plume. Our illustration shows a rather lax form.

Chara stachymorpha, Gant., **C. Kraussii,** Auct., and allied species.

Considerable ambiguity having arisen as regards the members of this group, and especially as to their nomenclature, we will endeavour to elucidate the facts.

For the confusion, Kuetzing is partly responsible. That author had access to specimens labelled by Braun, in various herbaria, often with MS. names. In several cases, Kuetzing published descriptions and figures of what he believed to be Braun's species before Braun had had the opportunity of formulating them. Unfortunately, Kuetzing's knowledge of the anatomy of the group was somewhat imperfect, with a result that his descriptions were often inadequate and the details of some of his figures inaccurate. The plates, however, in his Tabulae Phycologicae are for the most part so admirable, and in many cases so beautiful, and form such a very valuable contribution to the delineation of the Charophyta, that one is loth to find fault with them, though errors in detail have caused difficulty in identifying a few of them.

The earliest published species of the group under review, *C. stachymorpha*, was described by Ganterer in 1847. The description appeared in a footnote to his group "Fragiles" in the author's account of the Austrian Charophytes (Die bisher bekannt. Österr. Charen), and as that work may not be readily accessible, we reprint it.

"Ad hanc tribum refero:

Charam stachymorpham spec. nov. Caulis fere simplex nudus; distantia verticillorum sterilium inter se magna; fertiles solummodo in parte superiore ramorum parvorum circa pollicem longorum valde conferti et spiculas formantes, quae singulae in verticillis sterilibus sedent, prominent et saepe quidpiam nutant. Rami verticillati steriles pollicem fere dimidium longi, usque ad articulum terminalem conicum corticati, fertiles 1–2 lineas longi, usque ad articulum terminalem saepe quidpiam elongatum et acuminatum corticati. Ramuli laterales paleacei, lati et sporis longiores; genicula omnia ramorum verticillatorum fertilium occupantes, superiores breviores; Dioica; sporae oviformes; coronula conica; fascias numerare non potui.

Diese Art, die sich besonders dadurch auszeichnet, dass die fertilen Wirtel in kleine dichte Aehrchen gedrängt sind, wurde von Gueinzius bei Port Natel gesammelt und befindet sich im Herbarium des k.k. Museums in Wien."

The foregoing description enables us to identify the plant intended with a well-marked endemic South African species. Thanks to the courtesy of Dr. Melchior we have had the opportunity of examining a specimen of the type plant.

Abbreviated descriptions based upon Ganterer's appeared in Kuetzing's Species Algarum (1849), p. 522, and in Wallman's Forsok Syst. Charac. (1853), p. 100.

In 1867 Kuetzing (Tab. Phyc.) described and figured two species belonging to this group, under the names "Ch. Krausii * (A. Braun)" and "Ch. nivea (Steudel Herb.)." The first, *C. Krausii*, founded on a plant in Herb. Sonder collected by Zeyher at the Cape, is described as follows:—

"Ch. caule setaceo corticato non spirali, glaberrimo, verticillorum ramis 6–8, corticatis, bracteis unilateralibus, sporangio 13-striato subaequalibus, coronula conica clausa. Involucrum nullum."

Braun does not consider it safe from the description and figure to identify this, though it seemed to him to belong to his subsequently described *C. phaeochiton*. In the circumstances we think it best to drop the name, as ambiguous.

The second species, *C. nivea*, founded on a plant sent from the Cape by Ecklon and Zeyher, is depicted as sterile, and neither description nor figure seem sufficiently explicit to warrant the name being retained. Braun points out that the whiteness of the specimens of so-called *C. nivea* is due to their being bleached by the sun.

In Braun's invaluable work, Die Characeen Afrika's (pp. 931–5), considerable space is given to the members of the group. A collective species, *C. Kraussii*, is described, consisting of a var. *α genuina*, based on Krauss's

* Kuetzing's spelling of the specific name with one "s" was evidently an error, the species being named in honour of Ferdinand Krauss.

No. 2000, and var. *β stachyomorpha* based partly on Ganterer's species, but with two subvarieties, (*a*) *inermis* and (*b*) *papillosa*. A second species, *C. phaeochiton*, is also described.

It seems to us that the var. *α genuina* of Braun's *C. Kraussii* should not be combined with *C. stachymorpha*, and that the subvar. *papillosa* of the latter, with its ± developed stipulodes can hardly belong to Ganterer's species. Moreover, the recent alteration in the International Rules of Botanical Nomenclature, whereby later homonyms are rendered invalid, precludes us from using the name "C. Kraussii, Braun, non Kuetz.," and necessitates a fresh name being given to that segregate.

We have had the opportunity of examining a very large range of specimens of these plants, and put forward the following rearrangement as the most natural at which we have as yet been able to arrive. The members of the group exhibit great variability, and in a few cases it has not been found possible to place specimens with certainty under any one of them.

C. stachymorpha, Ganterer, Die bisher bekannt. Österr. Charen, p. 19 (1847); *C. Kraussii β stachyomorpha*, Braun, Monatsb. K. Akad. Wiss. Berl. for 1867, p. 931 (1868), excluding subvar. b. *papillosa*.

Heteromorphous, in the well-developed plant the fertile whorls usually forming elongated ± dense heads, sometimes interrupted below, the branchlets often incurved, with the segments somewhat swollen, and fewer (usually 4–5) and shorter than those of the sterile whorls. Sterile whorls often distant.

Stem-cortex diplostichous, or sometimes partially subtriplostichous, through the secondary cells joining very obliquely. In the lower part of the plant the cortex is sometimes simpler, almost haplostichous.

Spine-cells and stipulodes quite rudimentary, the latter in an irregular single row.

Branchlets usually 7 in a whorl, consisting of 3–8 corticate segments; the apical, and rarely a second segment, ecorticate; apical cell sometimes much elongated.

Bracteal appendages extremely variable in extent of development. Bract-cells with very long acuminate points, those of the fertile branchlets usually all developed and conspicuously divergent, but sometimes the posterior, and occasionally the intermediate ones also, short or even rudimentary. Bracteoles usually shorter than the fruit, sometimes rudimentary; bractlet usually shorter than the fruit, sometimes less than half its length, but occasionally elongated.

Oogonium usually ± coloured, the spiral-cells sometimes very dark brown. Coronula variable, the cells connivent, straight, or even slightly spreading. Ripe oospore black, truncate above, subcylindrical, or tapering from the middle downwards, 600–750 μ long, 275–375 μ thick, the ridges thin and low, showing 11–15 convolutions, often ending in long firm claws. The oospore is sometimes remarkably long and subcylindrical.

Antheridium c. 600 μ in diameter.

I. i. Cape. Cape div.: Muizenberg Vlei, Nov. 1897, A. H. Wolley-Dod 3563; same locality, Feb. 1921, E. L. S. 37; Cape Flats, various dates:

Ronde Vlei, E. L. S. 314, near Ronde Vlei, E. L. S. 67, Riet Vlei near Milnerton, E. L. S. 163, Witwater, E. L. S. 13, near Salt River, C. E. Moss 17026. Caledon div.: Vlei 2 miles west of Hermanus, Feb. 1924, J. Rennie (E. L. S. 164). George div.: Lakes at The Wilderness, Jan. 1924, E. L. S. 145 (*a*) and 165. Port Elizabeth div. : Redhouse, Oct. 1923, F. H. Holland (L. Britten 4071 and E. L. S. 190).

I. ii. NATAL. "Bei Port Natal," Gueinzius (the type plant).

The outstanding features appear to be: the crowded whorls of abbreviated fertile branchlets forming well-marked "foxtails" (see Pl. XVI, fig. 1); the rudimentary stipulodes in an imperfect single row; the long acuminate points of the bract-cells; the short or rudimentary bracteoles; and the normally short bractlet.

The single row of stipulodes removes the species *technically* from the section Diplostephanae, but its clear relationship with the other species points rather to its being an aberrant form of that section. The remarkably long tapering points of the bract-cells, however, show a close resemblance to those of some of the Haplostephanae.

In E. L. S. No. 13 numerous clustered spherical root-bulbils were present, resembling those found on *Lampthrothamnium papulosum*, *Chara aspera*, and a few other species. These have not been observed in other specimens belonging to the group, but may well have been overlooked, the rooting parts of Charophytes being rarely collected; moreover, root bulbils are apparently by no means constantly produced, their production being probably dependent on the nature of the soil.

C. amplexa, species nova.

"Ad Charam stachymorpham proxime cognata, sed ab ea differt, plantae feminae appendiculis bractealis (evolutis) ± aequalibus, tumidis, incurvatis, oogonium amplectendis, cacuminibus acuminatis."

Homoeomorphous, the fertile little differing from the sterile whorls.

Stem-cortex varying from regularly diplostichous to partially triplostichous. Spine-cells usually quite rudimentary, occasionally slightly developed.

Stipulodes quite rudimentary, in an irregular single row.

Branchlets 7–8 in a whorl, consisting of 6–9 corticate segments, and a single ecorticate apical cell.

Bract-cells of the ♀ with the anterior pair only developed, the rest rudimentary. Anterior bract-cells, bracteoles and bractlet, about the same length, all tumid, acute or acuminate, incurved, closely clasping the oogonium. Bract-cells of the ♂ all rudimentary; or the anterior, and rarely a second pair, short, somewhat tumid and acute.

Oogonium apparently always uncoloured. Coronula variable, from long and markedly connivent to short and rounded in outline. Ripe oospore black, ellipsoid, c. 475–675 μ long, 275–425 μ broad, often pointed at the apex, showing 11–15 thin low ridges, terminating in short thick claws.

Antheridium c. 825–950 μ in diameter.

Var. *a, longibracteata.* Bracteal appendages much exceeding the oogonium, with long acuminate points; apical-cells of branchlets somewhat elongated.

I. i. Cape. Cape div.: Valkenberg Vlei, near Mowbray, Nov. 1907, E. P. Phillips 129; same locality, Nov. 1911, W. T. Saxton (E. L. S. 14), and Oct. 1912, E. L. S. 29; vleis beside Klipfontein road, Cape Flats, Oct. and Dec. 1921, E. L. S. 43 and 76. Caledon div.: pools beside Swellendam road, E. L. S. 50.

Var *β, brevibracteata.* Bracteal appendages one-half to three-quarters the length of the oogonium, with short, acute, incurved points; apical cell of branchlets very short; coronula shorter than in var. *a.*

I. i. Cape. East London div.: Nahoon R. a little beyond ebb and flow, 1909, G. Rattray. (?) ♂ only, Gonubie R. within the tidal portion 1½ miles from the mouth, 1909, G. Rattray. Albany div.: Blauwkrantz, May 1929, M. A. Pocock (E. L. S. 298). Pondoland: Mtakati R., Umtata, Dec. 1927, M. E. Bleinkiron (Moss 17038); Mtakati R. between Umtata and Hleleuka Bay, Dec. 1927, L. Grant and M. E. Blenkiron (E. L. S. 248).

I. iv. Transvaal. Victoria Falls Power Co.'s pan, Witwatersrand, Sept. 1925, D. Weintroub (Moss 13329).

Resembling *C. stachymorpha* in many respects, but apparently never producing "fox-tails," and differing markedly in having the bracteoles and bractlet well developed, and, as well as the anterior bract-cells, tumid, incurved, and clasping the oogonium. The latter well-marked character we have not observed in any other species. The clasping bracteal appendages would seem to afford exceptional protection to the young fruit.

These appendages are usually contiguous throughout their length, and it is suggested that, were they adnate, they would form an organ similar to the utricle surrounding the fruit of the curious extinct fossil genus Clavator, found in the Middle Purbeck beds.

C. phaeochiton, Braun, Monatsb. K. Akad. Wiss. Berl. for 1867, p. 933 (1868); Braun and Nordstedt, Fragmente Mon. Charac., pl. vii, figs. 262–3 (1882).

Homoeomorphous, the fertile whorls not forming dense heads, nor consisting of much shorter branchlets than the sterile whorls.

Stem-cortex rather irregularly diplostichous, the secondary cells often joining ± obliquely, the primary series usually somewhat broader than the secondary.

Spine-cells rudimentary, or but slightly elevated.

Stipulodes rudimentary, or projecting very slightly, very irregularly 2-ranked, sometimes partially 3-ranked with other cells below the base of the branchlets.

Branchlets 7–8 in a whorl, consisting of 6–9 corticate segments, the apical cell often somewhat elongated, sometimes very short, and occasionally an ecorticate segment below.

Bract-cells whorled, the posterior often very short, the longer pairs subcylindrical or occasionally slightly ventricose, usually acute or acuminate; the anterior pair much varying in length, often exceeding the oogonium, the middle pair shorter, bracteoles and bractlet falling short of the oogonium, sometimes nearly rudimentary.

Spiral-cells of the oogonium with the exterior wall firmer than usual and ± coloured. Coronula c. 90–140 μ high, 180 μ broad, the cells usually connivent. Ripe oospore black, ellipsoid to subcylindrical, tapering slightly downwards, c. 500–650 μ long, 300–375 μ broad, showing 8–12 usually strong ridges, terminating in distinct claws.

Antheridium → c. 1000 μ in diameter.

I. i. Cape. Bredasdorp div.: Zoetendal's Valley, Dec. 1841, Krauss (type). Riversdale div.: Riversdale commonage, July 1923, Dr. Muir 2579. George div.: Lakes at The Wilderness, Jan. 1924, E. L. S. 145 (*b*); same locality, Jan. 1925, E. L. S. 201 (*a*); between George and Lang Brug, July 1931, E. L. S. 347. Port Elizabeth div.: Port Elizabeth valley, Nov. 1914, Florence Paterson 2321; Chatty River at Redhouse, Feb. 1924, E. L. S. 153. Albany div.: Blauwkrantz, near Grahamstown, Oct. 1925, L. Britten 4077 (E. L. S. 258). Kentani div.: Miss A. Pegler.

I. iii. Orange Free State. Cement dam at Leeuwfontein, Feb. 1927, Miss Hoffman (E. L. S. 237).

The outstanding characteristics of *C. phaeochiton* seem to be: (1) The remarkable irregularity of the stipular cells, accentuated in the very crude figure in Braun and Nordstedt's Fragmente (pl. vii, fig. 262). In the whole group the cells of the basal node of the branchlets are rather prominent, and are not always easy to separate from the stipular cells, when the latter are irregular. (2) The larger size of the antheridium.

The colouring and greater rigidity of the spiral-cells of the oogonium, upon which the name of the species was based, are very apparent in the type plant, but in others, which we feel bound to refer to *C. phaeochiton*, there is little or no colouring, and in *C. stachymorpha* also this character is evidently not stable. The thickness and prominence of the ridges on the oospore, which are also very marked in the type plant, seems liable to variation. The connection which Braun suggests with the spiny Mediterranean species *C. galioides*, D.C. is not apparent to us.

C. Kraussiana, nom. nov.; *C. Kraussii*, Braun (non Kuetz.), var. *α genuina*, Braun, "Die Characeen Afrika's," in Monatsb. K. Akad. Wiss. Berl. for 1867, p. 931 (1868).

The following is Braun's diagnosis:—

"Statura et habitus Ch. asperae, incrustatione subcinerascens. Caulis subtriplostiche corticatus, papillis instructus. Verticilli non heteromorphi. Foliorum articuli corticati 5–6, nudi (abbreviati) 1–2, fertiles 3–4. Foliola parum inflata, modice acuminata. Coronae stipularis cellulae superioris seriei elongatae, inferioris

papilliformes minimae. Antheridia minuta. Sporangii coronula brevissima, patule quinquedentata, nucleus fusco-ater."

Homoeomorphous, the fertile whorls not forming dense heads, nor consisting of much shorter branchlets than the sterile whorls.

Stem-cortex triplostichous or irregularly diplostichous. Spine-cells ± developed, spherical, often with a small projecting point, sometimes elongated.

Stipulodes of both series ± developed, but lower sometimes very short or nearly spherical, rarely both series almost rudimentary.

Branchlets usually 6 in a whorl, consisting of 6–8 segments, of which 2 are often ecorticate.

Bract-cells all developed, but the posterior often very short, anterior usually long, subcylindrical, obtuse or acute, rarely acuminate; bracteoles and bractlet long, cylindrical, often exceeding the fruit.

Oogonium with spiral-cells usually tinted, often dark brown; coronula usually short, the cells usually divergent, often terminating in an outward turning cusp. Oospore warm dark brown, ellipsoid, usually tapering somewhat at each end, c. 575–725 μ long, 300–325 μ broad, showing about 13 low ridges, with short basal claws.

Antheridium → 800 μ in diameter.

I. i. Cape. A characteristic plant of the temporary pools and vleis which form during the rainy season on the Cape Flats, near Cape Town. It was recorded from there by Krauss in Nov. 1838: "In Sumpfen der Cap'schen Ebene," Krauss 2000 (type), and has since been collected by Col. A. H. Wolley-Dod and by E. L. S. from many localities on these Flats (Wolley-Dod 3578, Nov. 1897; E. L. S. 39, 41, 59, 60, 65, 66, 71, 75, 78; various dates). Wolley-Dod also collected it near Fishoek Station, Cape Peninsula (Wolley-Dod 3505, Oct. 1897), and E. L. S. near Mamre Road Station, Malmesbury Division (E. L. S. 223*a*, Oct. 1925).

The plants which we have referred to this species show considerable variation in the stem-cortex, and in the degree of development of the stipulodes, both series of the latter being developed well in some (see fig. 8), the upper only in others, while in E. L. S. 223*a* both are almost rudimentary. The principal characteristics appear to be the developed spine-cells, the ± developed stipulodes of both series, the long subcylindrical bracteal appendages, with almost always acute or bluntish points (in E. L. S. No. 66 only have we found them acuminate), and the short coronula, with usually conspicuously divergent cells.

We would be glad to receive further specimens or records of these four species, to test what appears to be an interesting and perhaps significant geographical distribution. With the exception of one record of *C. phaeochiton* from the Orange Free State, and one of *C. amplexa* from the Transvaal, all specimens so far collected are from the southern coastal districts. Within this coastal belt *C. stachymorpha* ranges from Cape Town eastwards right to Natal, but the other species show a curiously limited distribution.

C. Kraussiana, a characteristic and very common plant of the Cape Flats, near Cape Town, is almost confined to these Flats, the only other record being less than 50 miles to the north. *C. phaeochiton*, on the other hand, does not occur within 100 miles of Cape Town, its range being from Bredasdorp eastwards to Kentani. The two varieties of *C. amplexa* again do not anywhere overlap, var. *longibracteata* being confined to the south-western and var. *brevibracteata* to the south-eastern coastal districts.

Summary.

This second instalment of notes includes descriptions and illustrations of eight new species of *Nitella*, viz. *N. axillocarpa*, *N. conifera*, *N. Duthieae*, *N. habrocoma*, *N. heteroteles*, *N. Knightii*, *N. ogivalis*, and *N. struthioptila*, and a revision of the group of species of *Chara* which Braun included under *C. Kraussii* and *C. phaeochiton*, with description of a new species, *C. amplexa*. The four plates illustrate all these species and also *N. plumosa*, Braun, and *C. stachymorpha*, Gant. The authors appeal for specimens from anywhere in Africa south of the equator.

EXPLANATION OF PLATES.*

Plate XIII.

Nitella axillocarpa, sp. nov. (figs. 1–8), from Portuguese East Africa.

1. ♀ plant, natural size.
2–3. Upper part of sterile branchlets. × *c.* 10.
4. Fertile whorl of ♂ seen from above. × *c.* 8.
5. Fertile whorl of ♀ seen from above. × *c.* 8.
6. Branchlet of ♀ with two oogonia. × *c.* 8.
7. Oospore. × *c.* 35.
8. Oospore membrane. × *c.* 300.

Nitella Knightiae, sp. nov. (figs. 9–15), from Salisbury, S. Rhodesia.

9. ♀ plant, natural size.
10–11. Apices of dactyls. × *c.* 12.
12. Fertile whorl of ♂ seen from above. × *c.* 8.
13. Fertile whorl of ♀ seen from above. × *c.* 6.
14. Oospore. × *c.* 35.
15. Oospore membrane. × *c.* 350.

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* No description of the plates had been drawn up by Mr. Groves, and no data dealing with them could be found among his papers. I have therefore compiled this explanation by a comparison of the figures with material in my collections. Of the two Madagascar species I have no material, so have not been able to give the magnification for the figures of these (Plate XVI, figs. 9–14).—E. L. S.

Plate XIV.

Nitella habrocoma, sp. nov. (figs. 1–6), from Belfast, Transvaal.

1. Plant, natural size.
2. Branchlet. × *c.* 15.
3. Portion of fertile branchlet. × *c.* 30.
4. Coronula. × *c.* 140.
5. Oospore. × *c.* 42.
6. Oospore membrane. × *c.* 750.

Nitella conifera, sp. nov. (figs. 7–11), from Malmesbury, Cape.

7. ♀ plant, natural size.
8. Apex of sterile branchlet. × *c.* 12.
9. Fertile branchlet. × *c.* 8.
10. Oospore. × *c.* 40.
11. Oospore membrane. × *c.* 300.

Nitella Duthieae, sp. nov. (figs. 12–19), from Victoria Falls, S. Rhodesia.

12. Plant, natural size, sterile.
13. Part of fruiting plant. × *c.* 4.
14. Apex of dactyl. × *c.* 50.
15. Upper part of sterile branchlet. × *c.* 30.
16. Branchlet with antheridia. × *c.* 6.
17. Fertile whorl with oogonia, seen from above. × *c.* 8.
18. Oospore. × *c.* 45.
19. Oospore membrane. × *c.* 500.

Plate XV.

Nitella struthioptila, sp. nov. (figs. 1–5), from Ceres Division, Cape.

1. ♀ plant, natural size.
2. Fertile branchlet of ♀. × *c.* 20.
3. Fertile branchlet of ♂. × *c.* 16.
4. Oospore. × *c.* 45.
5. Oospore membrane. × *c.* 400.

Nitella plumosa, Braun (figs. 6–9), from the Cape Flats, near Cape Town.

6. Plant, natural size.
7. Fertile branchlet of ♀. × *c.* 30.
8. Fertile branchlet of ♂. × *c.* 30.
9. Oospore membrane. × *c.* 400.

Plate XVI.

Chara stachymorpha, Gant. (figs. 1–4), from the Cape Flats, near Cape Town.

1. Plant, natural size.
2. Base of sterile whorl. × *c.* 35.
3. Oospore. × *c.* 35.
4. Bulbils. × *c.* 4.

Chara amplexa, sp. nov. (figs. 5 and 6).

5. Oogonium of var. *longibracteata*, from the Cape Flats. × *c.* 35.
6. Oogonium of var. *brevibracteata*, from Pondoland. × *c.* 35.

Chara phaeochiton, Braun, from George, Cape.

7. Base of sterile whorl. × *c.* 35.

Chara Kraussiana, nom. nov., from Cape Flats, near Cape Town.

8. Base of sterile whorl. × *c.* 35.

Nitella heteroteles, sp. nov. (figs. 9 and 10), from Madagascar.

9. Apices of dactyls.
10. Oospore.

Nitella ogivalis, sp. nov. (figs. 11–14), from Madagascar.

11. Fertile branchlet.
12–13. Apices of dactyls.
14. Oospore.

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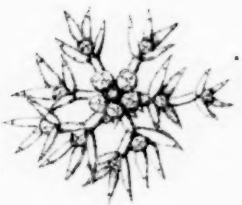
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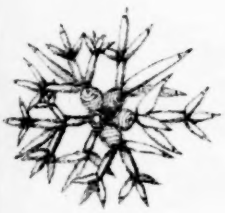
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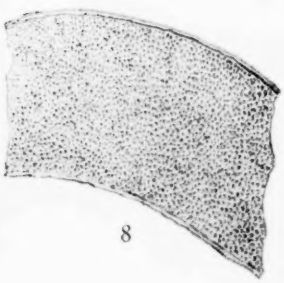
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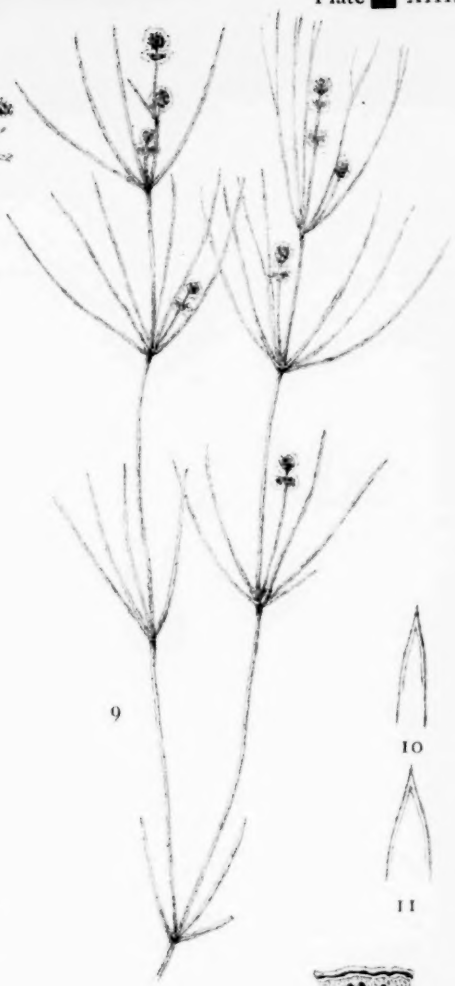
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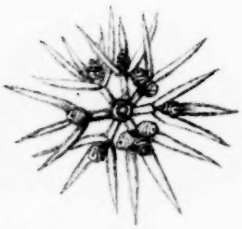
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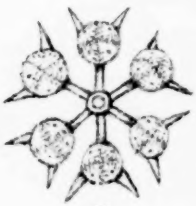
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M. & J. Groves del.

Whittingham & Griggs, Coll.

NITELLA AXILLOCARPA, 1-8.

N. KNIGHTIAE, 9-15.

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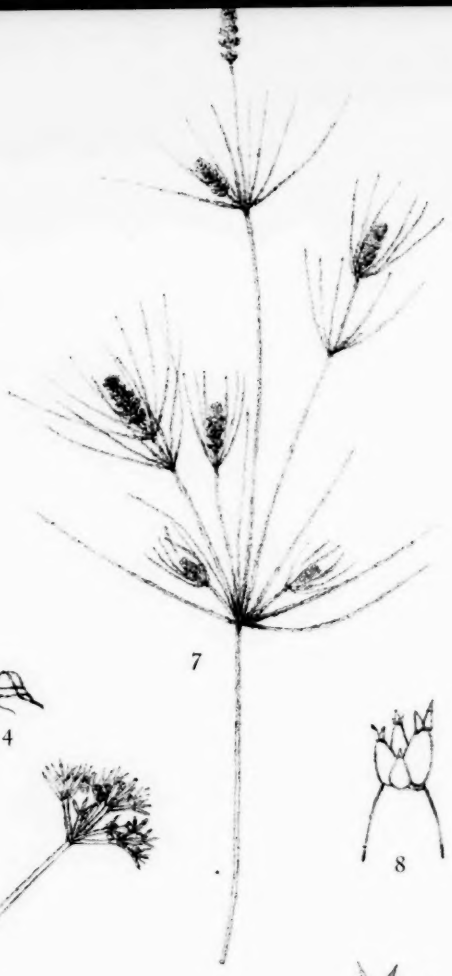
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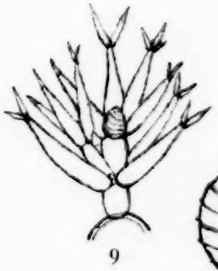
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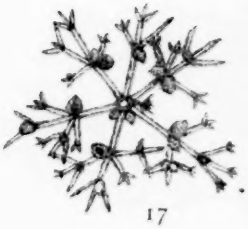
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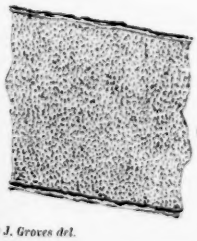
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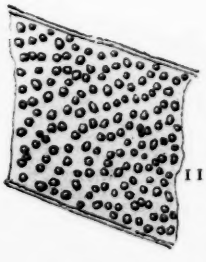
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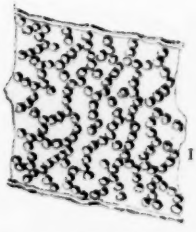
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M. & J. Groves del.

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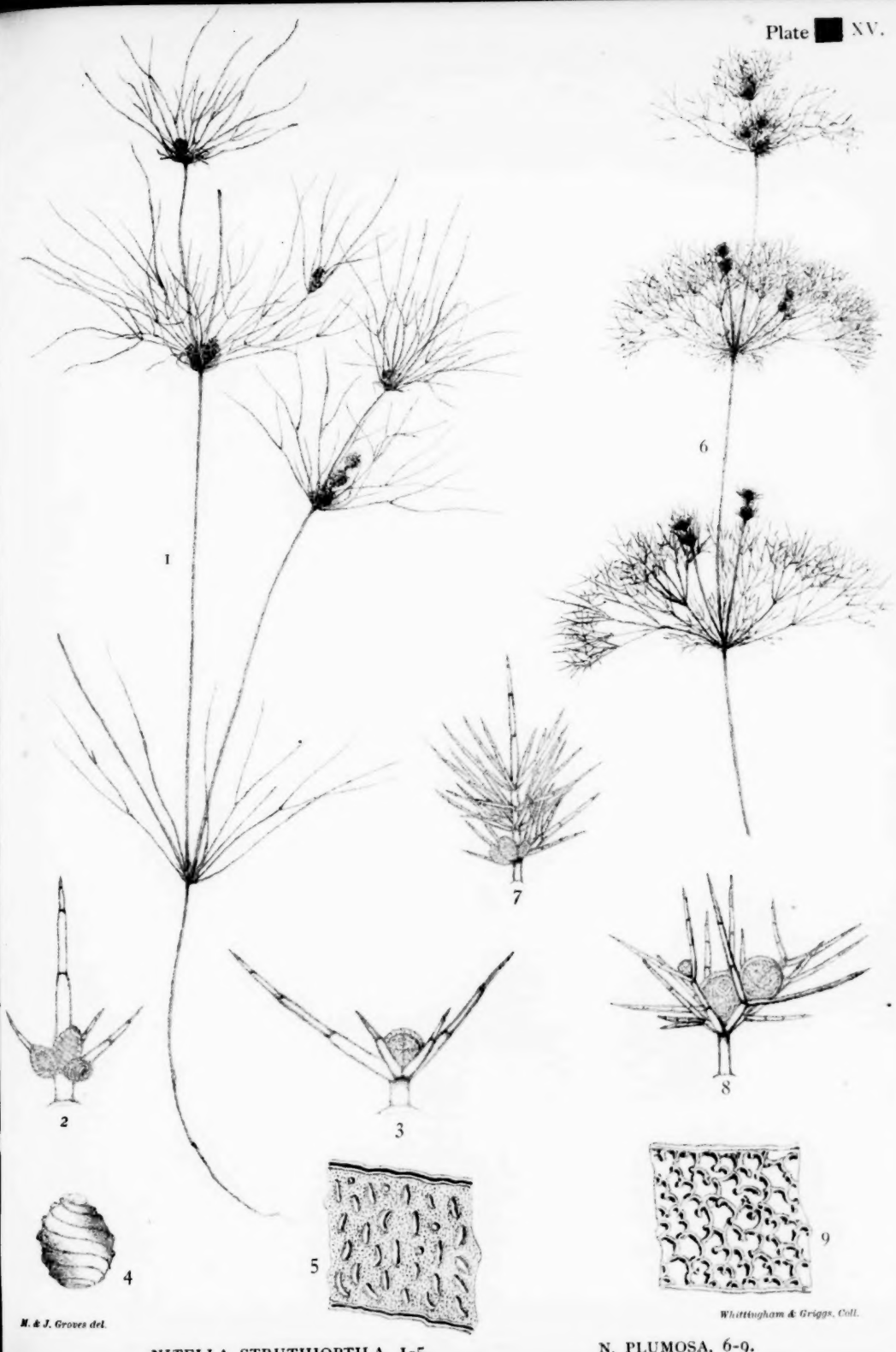
NITELLA HABROCOMA, 1-6. N. CONIFERA, 7-11. N. DUTHIEAE, 12-19.



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NITELLA STRUTHIOPTILA, 1-5.

N. PLUMOSA, 6-9.

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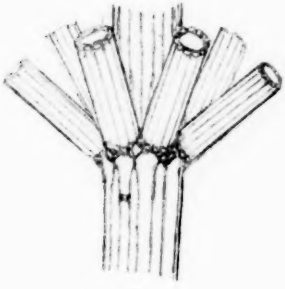
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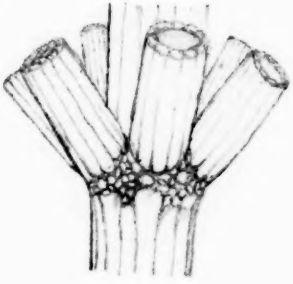
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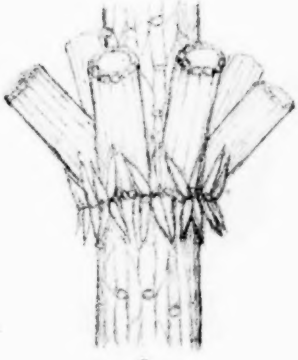
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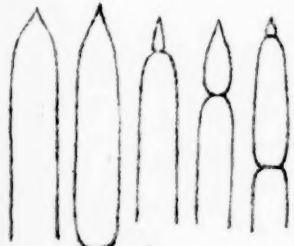
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1-4. CHARA STACHYMORPHA. 5. C. AMPLEXA *var.* LONGIBRACTEATA. 6. *var.* BREVIBRACTEATA.
7. C. PHAEOCHITON. 8. C. KRAUSSIANA. 9-10. N. HETEROTELES. 11-14. N. OGIVALIS.

SOUTH AFRICAN CADDIS-FLIES (*TRICHOPTERA*).

By K. H. Barnard, D.Sc., F.L.S.

(With fifty-two Text-figures.)

This paper forms the eighth report on the Fauna of the Mountain Ranges of the Cape Province, for the investigation of which I have received grants from the Royal Society of South Africa and the Research Grant Board.* My thanks and acknowledgments are herewith tendered to these bodies.

The species caught during the South African Museum's survey of South West Africa, under the auspices of the Administration of that territory, are also included.

The first Caddis-flies to be described from South Africa were *Macronema capense* and *Dipseudopsis capensis* (Walker, 1852), both of which were collected at Durban (Port Natal) and are more characteristic of the tropical regions than of the Cape. Then followed Hagen's (1864) description of four Caddis-cases and larvae (a fifth is, as Hagen suggested, a Psychid case) collected by Tollin at Swellendam. Only one of these was christened with a binomial name: *Molanna triangularis*.

From that time only a small number of specimens appear to have been collected casually from the eastern and northern parts of South Africa. In 1913 Ulmer was able to list only 7 species, to which he added 6 more, but not one of these records was from the south-west portion of the Cape Province, except Hagen's one definite species. Since then a further 11 species have been described, all except one (*Ecnomus similis*) from Natal, Rhodesia, or Portuguese East Africa.

The Cape has remained until late years an untouched field. The first imago Caddis to be collected in the Cape was the *Pseudoleptocerus*, collected in Clanwilliam by Dr. Leipoldt and sent to the South African Museum in 1898. In 1913 the late R. M. Lightfoot collected several specimens of one species at Ceres. The large increase in the list of species due to systematic collecting therefore is not surprising.

* Previous reports: 1. "Fresh-water Crustacea," Trans. Roy. Soc. S. Afr., vol. xiv, 1927. 2. "Colophon (Coleoptera)," *ibid.*, vol. xviii, 1929. 3. "Alder-flies," *ibid.*, vol. xix, 1931. 4. "May-flies," *ibid.*, vol. xx, 1932. 5. "Terrestrial Isopoda (Woodlice)," Ann. S. Afr. Mus., vol. xxx, 1932. 6. "Further New Species of Colophon," Stylops, vol. i, pt. 8, 1932. 7. "A New Corduline Dragonfly," *ibid.*, vol. ii, pt. 7, 1933.

In the following pages 15 new genera and 60 new species (and 1 variety) are described, and of these 49 species (and 1 variety) are from the south-west districts of the Cape. Both larval and pupal stages have been definitely correlated in 26 species; and the pupae only of 2 other species. The total number of species now recorded from South Africa, south of lat. 15° S., is 87, *i.e.* more than treble the number previously known.*

In achieving these results I have been very greatly indebted to my friends Mr. A. C. Harrison and Mr. H. G. Wood. Mr. Harrison has been interested in Caddises from the point of view of trout food, and has helped considerably in collecting and breeding. His assistance in regard to the paragraph on Economics is herewith acknowledged. Mr. Wood has been associated with me in many expeditions to the mountains, and has very generously provided motor transport. The value of his collecting is seen in the numerous records under the various species. To both these gentlemen I offer my sincere thanks.

Mr. F. G. Chaplin of the Jonkershoek Trout Hatchery has taken a keen interest in the work; and Mr. L. A. Day (Provincial Inland Fisheries Officer, Natal) has forwarded some larvae, including that described on p. 368.

Thanks are also due to past and present members of the Museum staff, who, though not specially interested in Caddises, have materially contributed to the formation of the Museum collection of dry specimens, in particular the late R. M. Lightfoot, Mr. R. W. E. Tucker, Dr. R. F. Lawrence, and Mr. C. W. Thorne.

To Mr. M. E. Mosely of the British Museum I am indebted for answers to several queries, and also for arranging an exchange of duplicate specimens. The localities of some of these are herein recorded with acknowledgments to the British Museum.

Terminology.—Tillyard's wing notation (Insects Austr., New Zeal., 1926) is here followed. It differs from Ulmer's notation (1907) in that the fifth apical fork is regarded as being formed by two branches of Cu_1 (Cu_{1a} and Cu_{1b}) instead of by Cu_1 and Cu_2. Consequently Ulmer's Cu_2 becomes Tillyard's Cu_{1b}, and 1A becomes Cu_2. Tillyard's statement (*loc. cit.*, p. 387) that Cu_1 is "always forked in both wings" should apparently be qualified, as there are exceptions, as, *e.g.*, his interpretation of the fore-wing of *Zelandopsyche* (Trans. N. Zeal. Inst., liii, 1921, p. 348, fig. 1) and the hind-wing of *Triaenodes* and *Adicella* (see *infra*, figs. 20 *a* and 35 *h*).

The wing-spot or nygme, situated in fork 2, which is bounded by R_4 and R_5, is found in most Caddises (except *Hydroptilidae*), and is often useful in the interpretation of unusual types of wing venation. Fork 1 is bounded by veins R_2 and R_3, fork 3 by M_1 and M_2, fork 4 by M_3 and M_4, fork 5 by

* From the whole of Africa (excluding the Algerian region) Lestage (1919A, p. 330) recorded 78 species; Ulmer in 1931 (p. 3) brought the total up to 143.

Cu_{1a} and Cu_{1b}; fork 5 is sometimes spurious, being bounded by Cu_1 (unforked) and Cu_2 (*cf.* fig. 3 *a* and *b*).

In the following descriptions where a structure is stated to be "chitinised," it is understood to mean more strongly chitinised than the surrounding membrane or structures (see meso- and meta-notum of the larva in fig. 4).

Technique.—For denuding the wings to observe the venation I have found the following method the most efficacious. After removing and submerging the wings in alcohol in a watch-glass, take a soft camel-hair brush (not too small, say a No. 2 or No. 3) and gently dab it on the wing in a *vertical* direction, cleaning first one side and then the other. Do not *stroke* the wing with the brush while attempting to hold it with a needle or scalpel. The vertical dabbing motion ensures that the hairs of the brush individually remove the setae and scales from the wing, while collectively they hold the wing down firmly. The most delicate wings, *e.g.* those of Hydroptilids, may be perfectly denuded in this manner.

Genitalia.—For purposes of specific differentiation the male genitalia are essential (except in the case of *Aethaloptera dispar* and *Chloropsyche maxima*), and it is necessary that they be prepared and cleared, otherwise no proper examination and description of them is possible. When it is not desirable to dismember a specimen, and the usual KOH method is inapplicable, immersion in parachlorophenol + chloral-hydrate is extremely satisfactory (dry specimens must, of course, first be soaked in alcohol, and cleaned in alcohol after examination). If a permanent microscopic mount is required, the cleared genitalia should be described *before* mounting; after mounting the interrelations of the parts cannot be properly studied.

Whereas the male genitalia exhibit in the majority of cases very distinctive specific differences, the female genitalia are inclined to be more uniform and generic in character. The latter are, however, very important, and wherever possible should receive attention as well as the male genitalia.

Frequently the structure of the one sex cannot be understood without reference to the other sex (*cf.* Sharp and Muir, Trans. Ent. Soc. Lond., 1912, p. 484). In this connection it may be useful to figure three instances where the two sexes have been collected, and have remained *in copula*. In the first (fig. 1 *a*) the simple claspers of the ♂ are applied to the dorsal surface of the terminal segment of the ♀, the 10th tergite acts as an upper penis sheath and enters the vulva together with the penis. The second (fig. 1 *b*) is similar, but there is no penis sheath, and the penis is retained in the vulva by two pairs of denticulate plates. In the third (fig. 1 *c*) the bifurcate claspers hook under the dorsal projection of the ♀, the apex of the 10th tergite only just enters, while the penis extends far into the vulva. The latter is unusually strongly chitinised and has an angular (in lateral view) dorsal recess against which the recurved penial spines impinge. A

sudden withdrawal of the penis is probably impossible, and this accounts for the ease with which pairs of this species may be captured and preserved *in copula*. In other species it is difficult to prevent the sexes separating immediately they are alarmed.

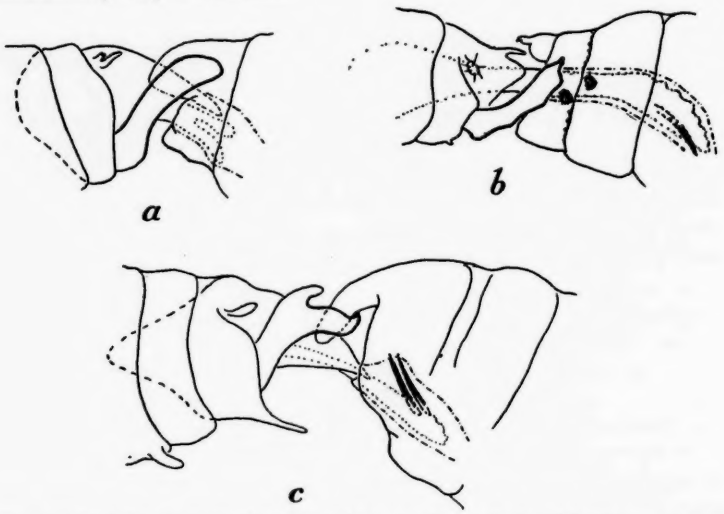

FIG. 1.—Semi-diagrammatic views of ♂ and ♀ *in copula*. *a*, *Barbarochthon brunneum* n. g., n. sp.; *b*, *Chimarrha ambulans* n. sp.; *c*, *Petroplax caricis* n. g., n. sp.

Metamorphosis.—Though the larval and pupal stages of a number of South African species have been discovered, as will be seen from the following pages, it will be observed that no mention is made of oviposition or the egg-masses. Only in the diagnoses of the families or genera, which are based in the main on Ulmer (1907 and 1909A), is the nature of the egg-mass, as observed in the European representatives, described. Up to the present in South Africa the act of oviposition has not been observed, and the egg-mass of only a single species (*Hydropsychodes*) has been identified or correlated. This gap in our knowledge of the South African Trichoptera remains to be filled.

There is also plenty of scope for further work in the correlating of the larvae and pupae, especially in the more tropical forms, *e.g.* the *Macronematinae*.

In the course of the present researches breeding from the larva has only been attempted in a few instances. The inhabitants of rapid streams are notoriously difficult to rear in captivity without special facilities. Nevertheless, the author has had larvae of *Petrothrincus triangularis* for some

months (mid-October 1932–March 1933) in a tank in which the water, though standing, has been frequently changed. They remained healthy, though they grew very slowly, and the resulting flies appeared to be undersized; from which it would seem that the essential factor is not fast-running water, but an adequate and suitable food-supply. It may be mentioned that tap water from a municipal supply may be unsuitable on account of its being chlorinated.

It has been found more satisfactory to make several visits to a locality until the time of emergence of the flies is discovered. By this means it is possible to secure at least two stages, or sometimes all three stages, at the same time. Pupae if sufficiently advanced will live for a week or two. If the pupae are not actually bred out, it is easy to dissect out the genitalia of a ♂ nearly ready to emerge, and correlate them with the fly.

The duration of the pupal stage has been determined in only a few instances. *Leptocerus harrisoni* takes 14 days in November (A. C. H.), *L. schoenobates* three weeks in March–April (K. H. B.), *Leptecho scirpi* a fortnight in March (K. H. B.), *Hydropsychodes lateralis* 13 days in October (A. C. H.), *Chimarrha ambulans* a fortnight in September, of which the prepupal stage lasts 3–4 days (K. H. B.), *Petrothrincus circularis* and *triangularis* three to four weeks in February–March (K. H. B.), and *Hydroptila capensis* a fortnight in March (K. H. B.).

Some species have several cycles throughout the year, and the pupal stage probably lasts longer in the colder months than in summer.

Larval Cases.—Several different kinds of Leptocerid and other Caddis-cases and larvae have been found, which have not yet been correlated with the imagos. Most of these are not included in the present paper, the exceptions being the Polycentropodid larva (p. 376, fig. 44) and the supposed larva of *Aethaloptera* (p. 368, fig. 40 *h–l*) and some Hydroptilids (fig. 51 *j*, *k*). These represent types of larvae not otherwise figured here, and are included as inducement to other students to work out their life-history.

Some of the Leptocerid larvae are interesting because they are not averse occasionally to occupying and adapting cases made by other Caddises, and sometimes also bracts or other tubular structures of vegetable origin, e.g. *L. scramasax* (fig. 29). The tubular elephant-tusk silken cases used by the Leptocerid larva described on p. 349 are exactly the same as those constructed by *Hydrosalpinx*, with the addition of the cowl of sand-grains; and, although it is not proved, I have a strong suspicion that these Leptocerid larvae take over the (? empty) cases of *Hydrosalpinx*.

Mention may be made, as a curiosity of Natural History, of a Caddis-case which is composed of sand-grains and includes a diamond. It was found in Brazil by Dr. David Draper, the geologist, and is now in the

collection of diamonds presented to the South African Museum by Mr. P. Ross Frames.*

Parasites.—The abdomens of both males and females, more especially the latter, are frequently infested with minute mites, as many as two dozen being found on one individual. Occasionally similar parasites (larval Hydrachnids) are also found on pupae in the pupal cases.

No instance of Hymenopterous (*Agriotypus*) parasites has been found. In Europe these parasites affect mostly the species of the subfamily *Goerinae* of the *Sericostomatidae*. In one locality where the pupae of the only known South African Goerine Caddis (*Sinion*) were abundant, a special look-out was kept for these parasites, but none were observed.

Distribution and Characteristics of the South African Caddis Fauna.—Any remarks under this heading must necessarily be provisional and subject to revision.

As a result of the present investigations the families *Rhyacophilidae*, *Hydroptilidae*, and *Sericostomatidae* have been added to the fauna list. No representatives, however, of the *Phryganeidae* or *Limnephilidae* have been discovered. The latter family seems to prefer cold water, and its absence is therefore explicable (*cf.* Ulmer, 1910A, p. 451).

There is a well-marked difference between the fauna of the south-west Cape and the eastern and northern districts, Natal and the Transvaal. In the latter regions there are a number of the larger Caddis-flies, mostly known also from tropical East and West Africa (*Aethaloptera*, *Polymorphanisus*, etc.).

In the Cape districts such forms are either absent or rare. Thus only one specimen each of *Macronema capense* and *Dipseudopsis capense* (and two larvae assigned to the latter) have been obtained. On the other hand, the families *Leptoceridae* and *Sericostomatidae* are represented by a number of species; and without doubt there are still more to be discovered. Some of the species are known from only a few localities, and frequently closely allied species are found in localities not far separated from one another. In the genus *Rhoizema*, for example, all the species make very similar larval and pupal cases, and the occurrence of a particular species in a locality cannot be assumed from the finding there of empty cases alone.

Up to the present, therefore, the *Leptoceridae* appear to be the dominant family in the Cape mountainous districts (*Leptocerus* 18 species, *Leptecho* 2 species, *Potamoryza* 1 species), with the *Sericostomatidae* next in order of abundance (15 species in 8 genera). In New Zealand Tillyard mentions this latter family as being the dominant family (Trans. N. Zeal. Inst., liii, p. 347, 1921), but this may possibly be due to the smaller Leptocerids being lacking in collections.

* See also C. T. Brues, "Jewelled Caddis-cases," Psyche, vol. xxxvii, p. 392, 1930.

As regards the intervening regions, the Eastern Province, Transkei, and Pondoland, our knowledge is a complete blank, except for one species of a tropical genus recently discovered at Grahamstown. It is hoped that someone will soon take up the study of Caddis-flies in this area.

Hot Springs.—In a stream arising from hot springs at Warmbaths, near Citrusdal, in the Olifants River Valley, the larvae of *Hydropsychodes* and *Chimarrha* were found, and an imago Hydroptilid on a stone nearby. In addition there were larvae of May-flies (Baetids and Leptophlebiids). The temperature of the springs is 108°–110° F. (Rindl., S. Afr. J. Sci. [1916], 1917, p. 534); that of the water some 200 yards downstream would be a few degrees less, though it is distinctly hot to the hand.

Economics.—The larvae (Caddis-worms), and to a lesser extent the flies, are important as fish food, though varying according to season, and also according to the kind of fish (see Clemens., Publ. Ontario Fish. Res. Lab., xxv, 1924, and Ricker., *ibid.*, xliv, 1932). The flies, known to anglers as "Sedge-flies" or "Sedges," and the emerging pupae have not been recorded as characteristic food of trout, but the cases and larvae are very common in the usual miscellaneous collection of food-items in trout stomachs. In certain circumstances Caddis-worms may appear as the predominating item of trout food. In New Zealand Hudson (New Zealand Neuroptera, 1904) and Phillips (Fish. Bull., No. 2, N. Zeal. Mar. Dept., 1929) found that nearly 80 per cent. of the contents of a number of trout stomachs was composed of Caddis-worms.

Parrot (Fish. Bull., No. 4, N. Zeal. Mar. Dept., 1932) found from 31–100 per cent. Phillips (*loc. cit.*, p. 12) considered that his own figure was "probably unduly high, owing to the persistence of such indigestible matter as the Caddis-cases compared with the more easily digestible organisms."

In South Africa data on this subject are accumulating, and Mr. Harrison has supplied the following instances :—

An eleven-inch trout (Dwaars River, Groot Drakenstein, October) contained 50 millipedes, 50 earth-worms, 10 dragon-fly nymphs, 3 large Alder-fly "creepers," 1 May-fly nymph, 10 white grubs, a large grass-hopper, 3 small river-crabs, some unidentified insect remains, and 10 small tubular sand-grain Caddis-cases. The "Circular Tortoise-case" (*Petrothrincus circularis*) occurs very frequently in the stomachs of trout taken in the Dwaars River during the summer (January to April). At times the trout are packed with these shield-like cases, which have probably been mistaken by anglers for fresh-water Limpets (*Ancylus*). This is most noticeable when the river is low. The cases must be picked off the rocks by the trout. On one such occasion A. C. H. observed a trout feeding amongst stones in less than a foot of water, and was convinced from its actions that it was "nosing" Caddis-cases from off the stones. The supply

of *circularis* cases in the locality would have been ample to nourish a number of trout during the peak period of the occurrence of this Caddis.

From certain instances which have come under Mr. Harrison's observation, it would seem that trout know Caddis-cases instinctively, and will accept on resemblance alone similar-looking objects; *e.g.* dead reed-bracts and solid vegetable fragments about the size of a Caddis-case were found in trout stomachs together with cases composed of vegetable matter (*Leptocerus* sp.) and membranous elephant-tusk cases (the same as described on p. 321).

Thus we can say that Caddis-cases form a fairly regular item in trout food, but without quantitative research on a large number of trout it would be impossible to arrive at a percentage. Mr. Harrison thinks that about 10 per cent. would be near the mark, and that on the whole the percentage of May-flies would not be greater. At times and under special circumstances, whether due to scarcity of other food or to opportunity would be hard to say, trout may feed almost exclusively on Caddis-cases.

It may be noted that in New Zealand, according to the latest researches of Percival (Fish. Bull., No. 5, N. Zeal. Mar. Dept., 1932) the trout have not succeeded in "eating-out" the Caddises, even after a period of 25–30 years.

Identification.—Instead of giving keys to the families, the following conspectus has been drawn up as a first-aid to identification. The character of the tibial spurs, *i.e.* the number on the fore, mid, and hind tibiae respectively, expressed as a formula, *e.g.* 0, 2, 2, is perhaps the most easily observed character used in the classification of Caddis-flies. Certain other characters are also included, but in general a comparison of the wing venation with the figures here given will suffice to place a specimen in its right genus with little trouble. For specific determination an examination of the genitalia is almost always necessary.

Conspectus of the South African genera according to tibial spurs, and other characters.

0, 2, 2.	*Oecetis*, some species *Potamoryza* *Setodes*	both wings narrow.
	Chloropsyche	hind wing very broad.
0, 2, 4.	*Hydroptila.*	
0, 3, 2.	*Aethaloptera.*	
0, 3, 4.	*Argyrobothrus.*	
0, 4, 4.	*Protomacronema.*	
1, 2, 2.	*Pseudoleptocerus* *Triaenodes* *Parasetodes* *Oecetis*, some species	see key to *Leptoceridae.*

1, 2, 2. *Homilia*, *Adicella*, *Leptocerus sylvaticus* and *oryx* — see key to *Leptoceridae*.

1, 3, 3. *Polymorphanisus*.

1, 4, 4. *Chimarrha*.

2, 2, 2. *Leptocerus*.

2, 2, 4. *Rhoizema*, *Aselas*, *Cheimacheramus*, *Petroplax*, *Barbarochthon* . . . maxillary palp ♂ less than 5-jointed — see key to *Sericostomatidae*.

Petrothrincus, *Hydrosalpinx* . . . maxillary palp ♂ 5-jointed.

2, 4, 2. *Phanostoma*.

2, 4, 4. *Crunoeciella*, *Dyschimus*, *Sinion* . . . . . median cell and fork 4 absent in fore wing.

Hydropsyche, *Hydropsychodes*, *Diplectrona*, *Macronema*, *Thylakion* — with ocelli — with fork 3 in hind wing . . . median cell and fork 4 present in fore wing.

Ecnomus (2 species) — no ocelli — without fork 3 in hind wing . . . median cell and fork 4 present in fore wing.

Myspoleo . . . . . fork 4 present but no median cell.

3, 4, 4. *Dipseudopsis* . . . . . with median cell in hind wing.

Ecnomus (2 species) . . . . . no median cell in hind wing.

The conspectus will apply also to the pupae, so far as the tibial spur formula is concerned. All the pupae so far discovered (in South Africa) have the anal appendages rod-like, except *Chimarrha*, *Thylakion*, *Dyschimus*, *Myspoleo*, and the Hydroptilids. With the help of these two characters, and the character of the pupal case as set out below, the pupae should be easy to identify.

Conspectus of Pupal Cases.

1. Case composed of vegetable matter.

   a. Cylindrical, composed of pieces of stick, reed, or leaves, arranged longitudinally . . . . . *Dyschimus*. *Leptocerus harrisoni*. *Leptocerus schoenobates*. *Leptecho scirpi*.

   b. Bivalve, minute, composed of green algae arranged more or less concentrically *Hydroptila capensis*.

2. Case composed of sand-grains.

   a. Case ovoid . . . . . *Chimarrha*. *Thylakion*. *Hydropsychodes*. *Myspoleo*.

b. Case tubular or roughly cylindrical . . . . . *Rhoizema.* *Cheimacheramus.* *Petroplax.* *Potamoryza.* *Leptocerus scramasax* and *stephanus*

c. Case cylindrical with larger pebbles attached laterally . . . *Sinion.*

d. Case flattened, shield-like, circular or triangular . . . . *Petrothrincus.*

e. Case bivalve, minute, like an Ostracod . . . . . Hydroptilid.

3. Case composed of silken secretion, membranous.

a. Elephant-tusk in shape.

i. With more or less numerous very minute sand-grains intermixed *Barbarochthon.*

ii. Entirely membranous . . . . . *Hydrosalpinx.*

b. Flask-shaped, minute, with 4 attachment discs . . . *Argyrobothrus.*

c. Bivalve, minute, like a caraway seed . . . . . Hydroptilid.

Mainly as a general guide for purposes of field-work the following table of the larval cases is given :—

Conspectus of Larval Cases and Larvae.

1. A definite case, mobile or tractable.

a. Case tubular, composed of vegetable matter.

i. Crawler . . . . . *Dyschimus.*

ii. "Swimming Sticks" . . . . . *Leptocerus schoenobates.* *Leptocerus harrisoni.* *Leptecho scirpi.*

b. Case bivalve, minute, composed of green algae . . *Hydroptila capensis.*

c. Case composed of sand-grains.

i. Case ovoid . . . . . *Myspoleo.*

ii. Case tubular or cylindrical . . . . . *Rhoizema.* *Cheimacheramus.* *Petroplax.* *Potamoryza.* *Leptocerus scramasax.*

iii. Case cylindrical with larger pebbles attached laterally . . *Sinion.*

iv. Case shield-like, circular or triangular . . . . *Petrothrincus.*

d. Case tubular, composed of sand-grains, with an outer covering of vegetable debris, *Leptocerus stephanus.*

e. Case membranous, composed of silken secretion.

i. Elephant-tusk shaped . . . . . *Barbarochthon.* *Hydrosalpinx.*

ii. Flask-shaped, minute, with attachment discs . . *Argyrobothrus.*

iii. Bivalve, minute, like a caraway seed . . . . Hydroptilid.

2. No definite case, larva more or less free-living amongst a network of silken threads.

a. Abdomen yellowish. Pronotum corneous. No abdominal gills . *Chimarrha.* *Thylakion.*

b. Abdomen green. Pro-, meso-, and metanotum corneous. Tufts of gills on abdomen . . . . . *Hydropsychodes.*

A prosternal spine is present only in *Dyschimus* and *Sinion.*

INAEQUIPALPIA.

Family Sericostomatidae.

Ulmer, 1907, p. 78; Lestage, 1921, p. 826 (larvae and pupae).

Imago.—Ocelli nearly always absent. Antennae about as long as fore-wing, basal joint strong, often elongate, or very elongate. Maxillary palp in ♂ reduced to 3, or 2, or a single joint, in ♀ 5-jointed; in ♂ often of abnormal shape, usually curving up in front of face, or forming a mask, thickly hairy or even scaly. Labial palp 3-jointed in both sexes. Discoidal cell in fore-wing always closed, in hind-wing not always. Venation often differing in the sexes. Membranous folds or pockets often present in ♂.

Larva.—Eruciform. Abdominal segments not deeply divided. Pronotum horny, meso- and metanotum varying. Prosternal spine present or absent. Lateral line very fine or absent. Gills usually present.

Pupa.—Variable, according to genus.

Remarks.—As this family is a repository for various forms whose systematic position is not clear, a sharp definition cannot be given. Several genera can be grouped more or less naturally into subfamilies (e.g. *Goerinae*), which will probably be raised later to family rank.*

Up to the present only the genus *Crunoeciella* has been recorded from Africa and Madagascar.

Seven new genera and 15 new species are here described.

Key to the African genera.

1. Tibial spurs 2, 4, 4.
   - *a.* Thyridial cell in fore-wing moderate. Discoidal cell in hind-wing (♀) closed.
     - i. Hind-wing narrow at base, discoidal cell present ♂ ♀, Cu_2 simple . . . *Crunoeciella.*
     - ii. Hind-wing broad at base, discoidal cell absent ♂, Cu_2 forked . . . . . *Dyschimus.*
   - *b.* Thyridial cell in fore-wing long, discoidal cell in hind-wing open . . . . . *Sinion.*
2. Tibial spurs 2, 2, 4.
   - *a.* Discoidal cell in hind-wing closed.
     - i. Fore-wing with apical forks 1, 2, (5), (♂) . . . . . *Rhoizema.*
     - ii. Fore-wing with apical forks 1, 2, 3, 5 (♂) . . . . . *Aselas.*
   - *b.* Discoidal cell in hind-wing open.
     - i. Fore-wing with apical forks 1, 2 (♂); 1, 2, 3, 4 (♀) . . . . . *Cheimacheramus.*
     - ii. Fore-wing with apical forks 1, 2, 5 (♂); 1, 2, 3, 5 (♀) . . . . . *Petroplax.*
   - *c.* Discoidal cell in hind-wing absent. Venation in hind-wing very anomalous, anastomosis obsolete. *Barbarochthon.*

Gen. *Crunoeciella* Ulmer.

Ulmer, 1905A, p. 68; 1907, p. 103; 1908, p. 2 and p. 3 (larva); 1930, p. 497.

Imago.—Tibial spurs 2, 4, 4. Ocelli absent. Basal joint of antennae somewhat longer than head, covered with hairs and scales. Maxillary palp ♂ 1-jointed, short, stout, upcurved, with scales as well as setae; in ♀ 5-jointed, slender. Labial palp slender or stout. Wings rather broad, ovoid, in ♂ with narrow scales on both wings as well as hairs, the latter more or less upstanding. Fore-wing with forks 1, 2 ♂, 1, 2, 3, 5 ♀; hind-wing with only fork 2 (Ulmer, fork 1) in ♂, forks 1, 2, 5 ♀. Discoidal cell in both wings closed in both sexes, in fore-wing long, in hind-wing short. Thyridial cell moderate or rather long. In ♂ Cu_2 and 1A in fore-wing and Cu_1 in hind-wing sometimes obsolete or modified into a thickened vein or groove. Genitalia ♂, 10th tergite divided into 4 pieces, the outer ones arising at a lower level and ending acutely; preanal appendages absent (unless represented by the acute processes mentioned above); penis strongly curved; clasper 2-jointed (Ulmer) or 1-jointed.

Larva.—See Ulmer, 1908, p. 3.

Remarks.—Ulmer states that only fork 1 is present in the hind-wing ♂, and in his figures of the three species the first pair of veins arising from the discoidal cell are so numbered. None of his figures show the wing-spot on hind-wing. In the species described below the wing-spot is clearly marked, and there is no reason to regard the fork containing the spot as other than the normal fork 2. Moreover, comparison with Ulmer's fig. 4 (1908) of the ♀ seems to leave no doubt that it is fork 1 which has disappeared in the ♀ by fusion of R_2 and R_3.

All the three species described are stated to have 2-jointed claspers in the ♂. With the possible exception of *brunnea*, I doubt whether the claspers really are 2-jointed. In the present species, which bears a very close resemblance to *sjoestedti* and *scotti*, the claspers are unquestionably only single-jointed.

In *sjoestedti*, and apparently also the other two species, the labial palps are slender, whereas in the present species they are stout.

The original species *brunnea* Ulm. (1905) came from Madagascar; *sjoestedti* Ulm. (1908) and *scotti* Ulm. (1930) from Kilimanjaro and Abyssinia respectively. The following species is closely allied to the two African species in having very similar ♂ genitalia; and in this respect all three differ somewhat markedly from the Madagascan form.

* See Ulmer, 1910A, p. 452; and Tillyard, Tr. N. Zeal. Inst., vol. liii, p. 347, 1921.

Crunoeciella caffrariae n. sp.

(Fig. 2.)

Imago.—♂. First antennal joint half the length of head across (and including) the eyes, covered with thickened setae and narrow scales. Maxillary palp club-shaped with an upstanding laminate process near apex, clothed with thickened setae and moderately broad scales. Labial palp stout, 1st and 2nd joints together about as long as maxillary palp, 3rd joint shortest. Fore-wing closely resembling that of *scotti*, but Cu_1 not so strongly bent at end of thyridial cell. Cu_2 visible proximally for a short distance, then very faint, obscured and overlain by the strongly thickened 1A, but visible again distally near margin. Hind-wing resembling more closely that of *sjoestedti*. Narrow scales scattered over both wings, most numerous in the distal and costal areas. Genitalia, 10th tergite convex in lateral view, in dorsal view deeply cleft, the lobes subacute

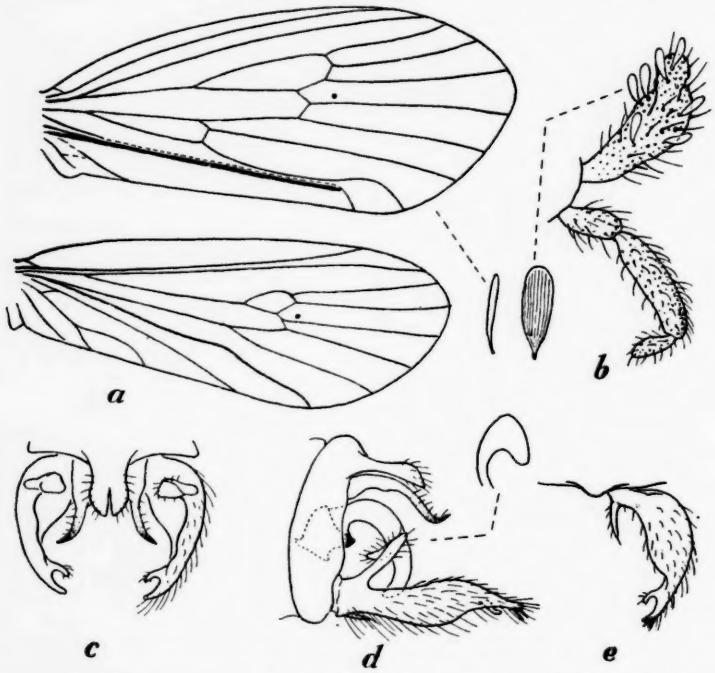

FIG. 2.—*Crunoeciella caffrariae* n. sp. *a*, fore- and hind-wings, with scale from fore-wing; *b*, maxillary and labial palps ♂, with scale from maxillary palp; *c*, *d*, dorsal and lateral views ♂ genitalia, with upper process of clasper in posterior view; *e*, ventral view of 9th sternite and one clasper.

and only slightly divergent; at a lower level a pair of slender, curved, apically acute processes, somewhat spiniform and strongly chitinised; penis stout, strongly curved, apex somewhat spatulately expanded, the basal portion with a strongly chitinised knob below; clasper elongate, slender, spoon-shaped proximally, distally strongly narrowed in lateral view, on upper margin near base an upstanding process with expanded apex curving inwards, apex truncate, with 2–3 stout blackish spines, and a short subapical digitiform process on inner side, at base of lower inner margin a short spiniform process; 9th sternite with slight bluntly triangular median projection.

Fore-wing 6·5 mm. Antennae? (broken).

Colour (in alcohol), head and thorax fulvous. Wings brown, the thickened hairs and scales blackish. Legs and antennae ochraceous.

Locality.—Donkerbosch Kloof, Grahamstown (R. F. Lawrence, February 1933, 1 ♂).

Remarks.—The discovery of a species of this genus so far south is very interesting, and indicates the probable presence of other tropical and subtropical genera in the Eastern Province and Natal. As mentioned above, its affinities lie with the other two African species more than with the Madagascan species.

Dyschimus n. g.

Imago.—Tibial spurs 2, 4, 4. Ocelli absent. Antennae slightly longer than fore-wing, 1st joint broad and about equal in length to the 3 following joints together. Labrum linguiform, longer than broad. Maxillary palp ♂ apparently 2-jointed, but really 3-jointed, 1st joint cylindrical, 2nd and 3rd fused, but with the line of junction indicated by paler chitin, together forming a flattened lamina curving upwards against the face, their outer surface with thickened hairs; in ♀ 2nd, 4th, and 5th joints subequal, 3rd slightly longer, 1st shorter. Labial palp short, in ♀ distinctly shorter than maxillary palp, 1st joint with an apical downwardly curved process, 2nd longest, flattened antero-posteriorly, 3rd longer than 1st, nearly cylindrical. Apical forks 1, 2, 3, 5 in fore-wing in both sexes, though 5 really spurious in ♂; in hind-wing forks 2, 5 in ♂, 1, 2, 5 in ♀. A distal cross-vein between Sc and R in fore-wing; in hind-wing R distally incomplete, a cross-vein connecting Sc with R_2 (or R_{1+2}). In fore-wing apical fork 2 either sessile or very shortly stalked. In hind-wing Cu_2 forked; discoidal cell in ♀ closed, in ♂ absent. In fore-wing Cu_1 single in ♂, forked in ♀, the fork sessile from junction of cross-vein uniting Cu_1 and Cu_2; in ♂ distal portion of Cu_2 runs straight to margin parallel with Cu_1, but in ♀ is deflected proximally by interpolation of second branch of Cu_1. Genitalia ♂, preanal appendages represented by small knobs, or absent, claspers 1-jointed; ♀ with supra- and subanal plates.

Larva.—Mandibles with internal tuft. Mesonotum with two rather large chitinised plates. Fore-leg not remarkably robust. Middle leg longest. Prosternal spine present. Dorsal hump of 1st abdominal segment feeble. No gills on segment 1. Anal holdfasts well developed. Case cylindrical, sometimes subtriangular in cross-section, straight, composed of pieces of vegetable debris.

Pupa.—Labrum quadrangular. Mandibles slender. Mid and hind tarsi fringed. Posterior margin of 1st abdominal segment with a dorsal projecting ridge. Anal appendages lobiform, dorsally hollowed, spoon-like. Gills on dorsal, lateral, and ventral surfaces. Dorsal plates on segments 4–8, postsegmental also on segment 5. Labial palp with inner process corresponding with process on 1st joint in imago.

Case the same as that of larva, ends closed with small sand-grains, hind end also with a sieve-like plate.

Genotype: *D. thrymmifer* n. sp.

Remarks.—In general facies of the adult, and the 1st abdominal segment and anal appendages of the pupa, this genus bears a strong likeness to a Phryganid; but the absence of ocelli and the maxillary palp of ♂ exclude it from that family.

When at rest the wings are folded at a very low angle over the abdomen, almost flat in comparison with *Rhoizema* and other Sericostomatids.

Dyschimus thrymmifer n. sp.

(Figs. 3, 4.)

Imago.—Head and thorax dark or castaneous brown with blackish hairs. Legs fulvous, tarsi annulate. Antennae fulvous. Wing membrane grey, neuration slightly darker. Both wings densely hairy, fore-wing in fresh specimens almost furry, mottled with buff and sepia, the wing-spot in fork 2 pale, a similar pale spot at base of thyridial cell and another between these two, with intervening dark spots, apical margin dark with a pale spot between each pair of veins from Sc to 2A; hind-wing uniform pale grey.

Fore-wing 12–16 mm. Antennae 12–18 mm.

Genitalia ♂, 9th segment dorsally with a low rounded transverse ridge, bearing long hairs laterally, and two small conical knobs, probably representing the preanal appendages, ventrally with two submedian rounded hairy lobes (sometimes longer than represented in figure); 10th tergite triangular, deeply cleft, apices of lobes subacute, straight; clasper triangular, apex acute, falcate, curved downwards, upper margin with rounded lobe; penis apically cleft, the ventral lobe spatulate or gauge-like, the dorsal lobe bifurcate, each lobe ending in a strongly chitinised recurved spine. ♀, the upstanding submarginal oblique ridge on the supra-anal plate is low in one specimen, but prominently lobed in another.

Larva.—Mesonotum with two transversely quadrangular chitinous plates, narrowly separated, antero-lateral corner strongly chitinised, with 3–4 hairs. Metanotum with five small chitinised areas, each with 1–2 hairs. Prosternal spine slender. Abdominal segment 1 with four small chitinised areas dorsally, each with a long hair, ventrally with two small submedian areas and a smaller one more laterally, each with a long hair. Gills on segments 2–7 as in table.

	D.	L.		V.
II	1–3 3–4		— 2–3	— 3–4
III	3–4 3–4	3 —	— 2–3	3–4 3–4
IV	3–4 3–4		— 2	3–4 3–4
V	2–4 2–4		— 1–2	3–4 3–4
VI	1–3 —			2–3 2–3
VII				— 2

Up to 16–18 mm.

Head and pronotum deep castaneous, mesonotal and other chitinised areas, legs and anal claws ochraceous or fulvous, abdomen pale yellowish or whitish.

Case composed of bits of dead stick, leaves, and other vegetable debris, cylindrical, cross-section round, or in younger stages more triangular. Sometimes composed wholly or in part of sphagnum moss, or a few sand-grains may be incorporated.

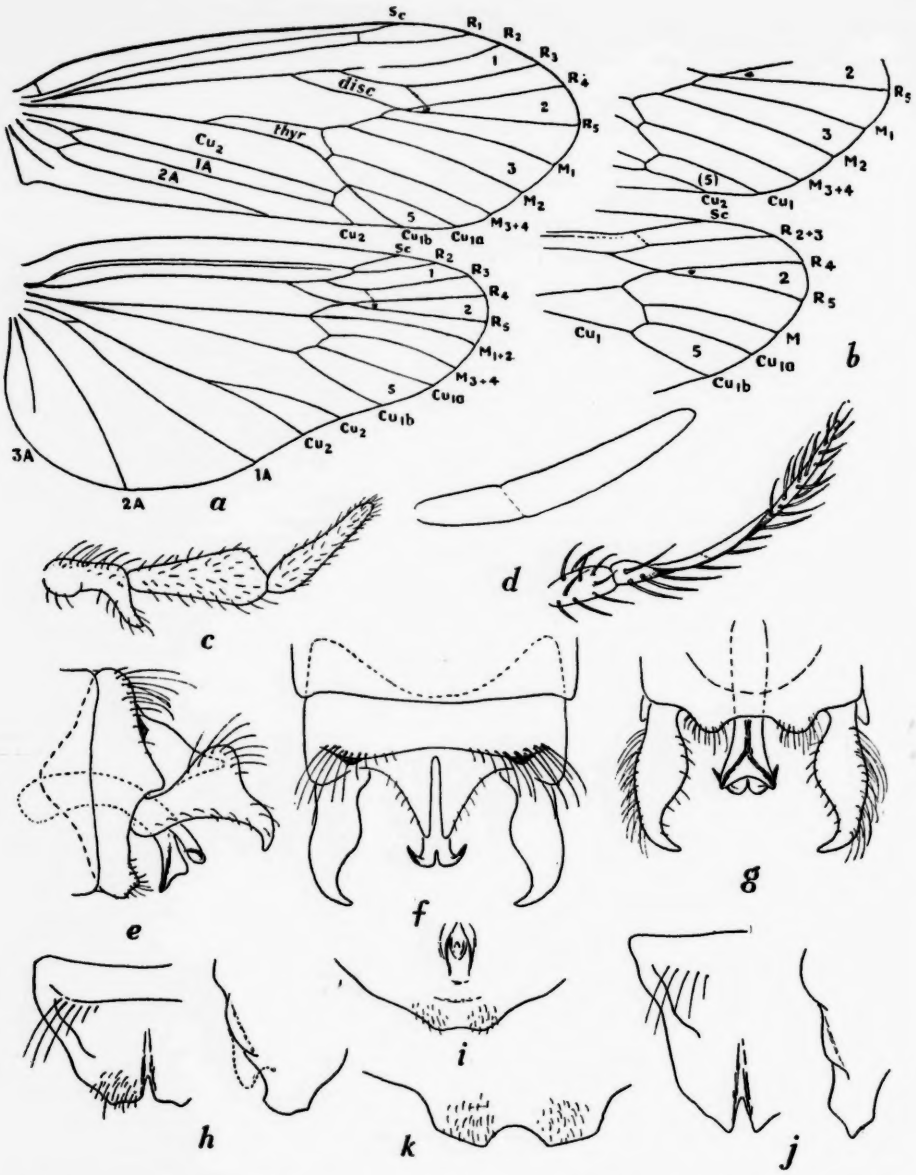

FIG. 3.—*Dyschimus thrymmifer* n. g., n. sp. *a*, fore- and hind-wings of ♀; *b*, portions of fore- and hind-wings of ♂; *c*, labial palp; *d*, maxillary palp of ♂ seen laterally, and with the 2nd (fused 2nd and 3rd) joint viewed dorsally, hairs omitted in latter; *e*, *f*, *g*, lateral, dorsal, and ventral views of genitalia of ♂; *h*, dorsal and lateral views of supra-anal plate of ♀ (Table Mt.); *i*, apical margin of subanal plate of ♀ (Table Mt.); *j*, *k*, the same of a specimen from Wellington Mts.

Pupa.—Labrum transverse. Mandible elongate, inner margin smooth. Lateral line beginning on segment 4. Gills as in table.

Spines on dorsal abdominal plates 3–6 presegmental; postsegmental plates on segment 5 transversely ovate, with 10–12 spines. Anal appendages transverse, each with a narrow notch near the median line.

	D.	L.		V.
II	4	4	—	—
	4	4	4	4
III	4	4	4	4
	4	—	4	4
IV	4	3	4	4
	4	2	3	4
V		2	4	4
		—	2	4
VI		1	3	—
		—	—	4
VII				—
				3

15–18 mm.

Case the same as that of larva; both ends closed with small sand-grains, those at hind end not so numerous and leaving a gap which is filled with a sieve-like mesh.

Localities.—Table Mt., Cape Town (K. H. B.); Witte River, Wellington Mts. (K. H. B., Nov. 1922); River Zonder End Mts. (K. H. B., Nov. 1928, H. G. Wood, Jan. 1933); Gt. Winterhoek Mts., Tulbagh (K. H. B., Nov. 1932).

Remarks.—The ♂♂ from the Wellington, Gt. Winterhoek, and River Zonder End Mts. agree in all respects with the Table Mt. specimens. A ♀ from the Wellington Mts., however, has a more elongate supra-anal plate of slightly different shape, and a differently shaped subanal plate.

Larvae similar to those from the above localities have been found at Jonkershoek (Stellenbosch) and Bosch Kloof, Keeromberg (Worcester), but no adults have yet been obtained. The cases from Swellendam, referred by Hagen (1864, p. 248) to *Limnephilus* sp., may be this species.

Habits.—The imagos occur between November and April. Larvae can be found throughout the year in the less strongly flowing parts of the small streams, on top, and in the ravines on the slopes, but not below about 1000 feet altitude.

The pupal cases are anchored in crevices of stones, or among moss, or the debris on the bottom of the pool.

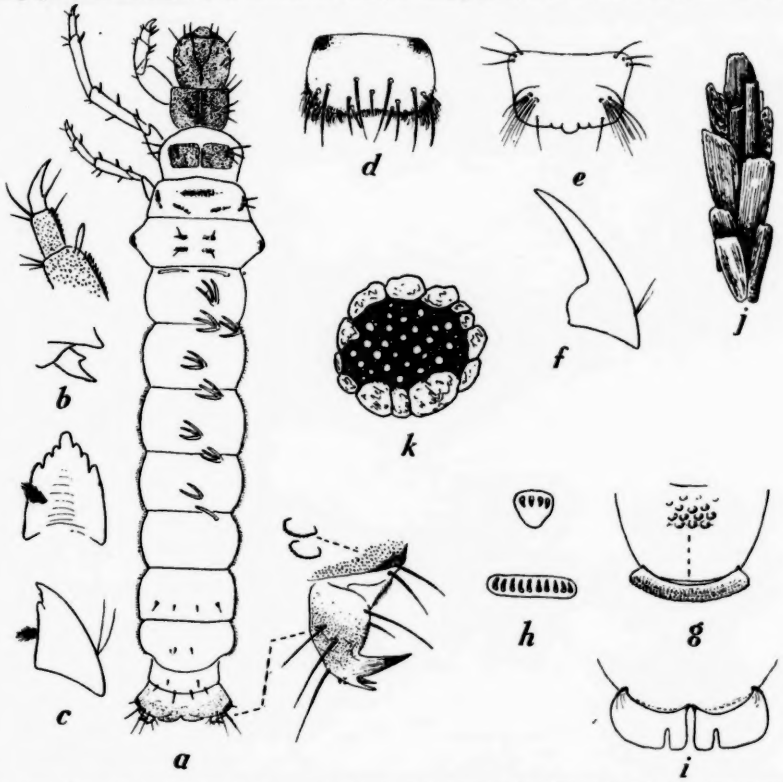

FIG. 4.—*Dyschimus thrymmifer* n. g., n. sp. *a*, larva, with apex of fore-leg and anal claw further enlarged; *b*, plaque d'appui of fore-leg; *c*, inner and dorsal views of mandible of larva; *d*, labrum of larva; *e*, labrum of pupa; *f*, mandible of pupa; *g*, 1st abdominal segment of pupa, with sculpture further enlarged; *h*, pre- and postsegmental dorsal plates of 5th segment of pupa; *i*, anal plates of pupa; *j*, case; *k*, membrane closing hind end of pupa case.

Dyschimus collyrifer n. sp.

(Fig. 5 *a–e.*)

Imago.—Resembling *thrymmifer*, but more uniformly coloured, smaller, and with differently shaped genitalia.

Fore-wing 11 mm. Antennae 13–14 mm.

Genitalia ♂, margin of 9th sternite without projecting lobes, processes of 10th tergite more elongate, apices turned upwards and outwards; clasper bilobed, apices of both lobes rounded; penis with a pair of chitinised appendages arising on ventral surface about midway, and a membranous appendage on dorsal surface. ♀ unknown.

Larva.—Resembling that of *thrymmifer*, but with slight differences in the gill formula, *e.g.* no presegmental gills on segment 2.

Case similar to that of *thrymmifer*, but composed more of short lengths (5–8 mm.) of reed, and thus showing a more definite spiral arrangement.

Pupa.—Labrum less transverse than in *thrymmifer*. Anal plates each with a wider notch, and the inner distal angle bevelled off. Otherwise closely similar to that of *thrymmifer*.

Localities.—Zwartberg Pass, 5000 feet, Prince Albert Division (K. H. B. and H. G. Wood, February 1932, 1 ♂, 1 pupal skin, and larvae); Montagu Pass, N. of George, 1000 feet (H. G. W., April 1933, 1 ♂ and larvae); Bosch Kloof, Keeromberg, Worcester (K. H. B., Jan. 1930, 1 ♂).

Dyschimus ensifer n. sp.

(Fig. 5 *f–k.*)

Imago.—Head and thorax dark fulvous, with black hairs. Legs and antennae fulvous. Wing membrane greyish-brown, with a slightly hyaline spot at upper distal corner of thyridial cell, pubescence greyish but mostly rubbed off.

Fore-wing 9 mm.

Genitalia ♂, 9th tergite triangularly produced, apex with minute notch, 9th sternite medianly excised; no knobs representing preanal appendages, merely a group of setae; 10th tergite deeply cleft, lobes strongly curved downwards, apices subacute, turned slightly outwards, and bearing on their lower (antero-inferior) edge 5–6 large sword-like spines; penis apically bifid; clasper cylindrical, somewhat tapering, distally bifid, the outer process spiniform, the inner one apically truncate, with outer and inner apical angles dentiform, and three prominent sword-like spines projecting outwards.

Locality.—Knysna (L. Peringuey, October 1916, 1 ♂).

Remarks.—The sword-like spines on the 10th tergite and claspers are a special feature.

The neuration of the fore-wing resembles that of *thrymmifer*, but shows a rudiment of fork 5, Cu_{1b} being indicated proximally but not reaching the margin. The neuration of the hind-wing in the costal area seems to be abnormal, though it is quite symmetrical in both hind-wings.

Sinion n. g.

Imago.—Tibial spurs 2, 4, 4. Ocelli absent. Antennae about as long as fore-wing, basal joint long, equal to the 3 (or 4) following joints together. Maxillary palp ♂, 1st and 2nd joints short, 2nd subtriangular, with long hairs on outer surface, 3rd long, stout, covered with hairs and scales, the scales narrow on inner surface, becoming broader laterally, and very broad on outer surface where they are arranged in a sharply demarcated band of 3–4 series, imbricated. Labial palp short, 2nd joint longest, 1st shorter than 3rd. In fore-wing apical forks 1, 2, 3, 5, fork 3 stalked, 5 sessile from point of thyridial cell. In hind-wing apical forks 1, 2, 3, 5; discoidal cell open. No pouch-like folds in ♂ wings. Near posterior margin of 6th abdominal sternite 6–8 stout spines. Genitalia ♂, preanal appendages slender, club-shaped, 10th tergite narrow, linguiform, below which are two slender processes, claspers 1-jointed (very obscurely 2-jointed). ♀ unknown.

Larva.—Mandibles stout, inner margin setose. Clypeus broad in front, rapidly narrowing. Prosternal spine present. Pronotum with antero-lateral angles acute. Mesonotum with three pairs of adjacent chitinised plates. Metanotum with three pairs of widely separated small plates. Legs subequal, fore-leg not stout, claws with long basal spine. Abdominal segments well marked. Lateral line well developed. Gills slender, developed chiefly posteriorly.

Case composed of sand-grains with several (3–4) larger ones attached along each side, hind end closed with a membrane with circular aperture.

Pupa.—Mandibles moderately slender, inner margin finely serrulate. Labrum subquadrangular, slightly transverse. Maxillary palp ♂ as long as, and stouter than, labial palp. Mid tarsi fringed. Abdominal segment 1 with dorsal transverse arcuate ridge on hind margin, minutely scabrous. Gills fewer than in larva, and very delicate. Dorsal plates on segments 3–6, postsegmental also on segment 5. Lateral line strongly developed on segments 5–8. Anal appendages rod-like, very slender, apically curved, minutely spinulose.

Case the same as that of larva. Hind end closed by a membrane with several apertures and sometimes one or two small sand-grains. Front end closed by a large grain of sand, between which and the margin of tube are a series of narrow slit-like apertures, chiefly laterally and dorsally (*cf.* Lloyd, Bull. Lloyd Libr. Entom., Ser. 1, 1921, fig. 119).

Remarks.—Distinguished from the other Goerine genera by the scaling on the ♂ maxillary palp and the single-jointed claspers, though very near to *Lithax*.

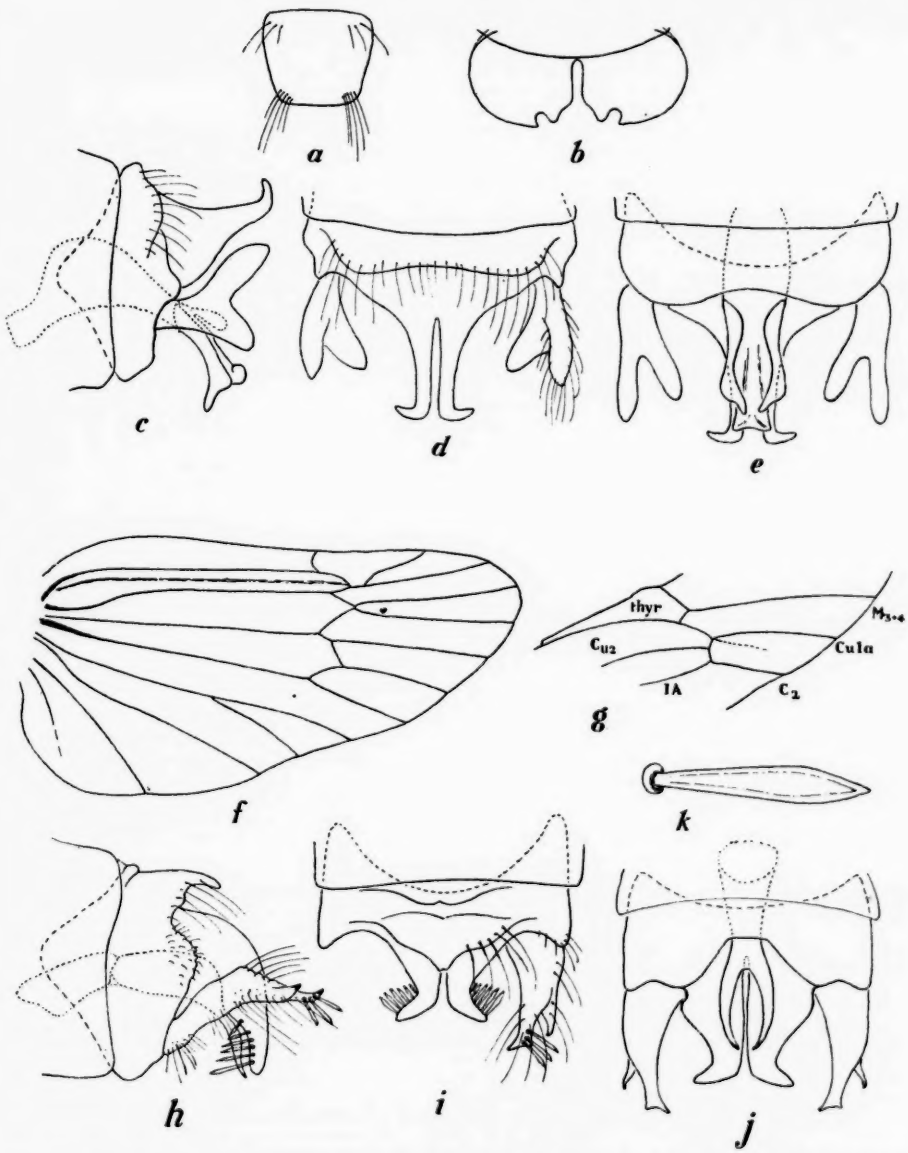

FIG. 5.—*Dyschimus collyrifer* n. sp. *a*, *b*, labrum and anal plates of pupa; *c*, *d*, *e*, lateral, dorsal, and ventral views of genitalia of ♂. *Dyschimus ensifer* n. sp. *f*, hind-wing; *g*, portion of fore-wing; *h*, *i*, *j*, lateral, dorsal, and ventral views of genitalia of ♂; *k*, one of the spines from apex of 10th tergite, or clasper.

Sinion hageni n. sp.

(Fig. 6.)

1864. *Trichostoma* sp., Hagen, p. 237.

Imago.—Head and thorax fulvous with pale hairs. Legs ochraceous. Basal joint of antennae fulvous, the rest fuscous. Wings pale brown with golden hairs.

Fore-wing 5·25–6 mm.

Genitalia ♂, 9th sternite projecting slightly as a rounded triangular point, clasper biramous, the inner lower branch slender, acute, strongly chitinised, the upper outer branch bluntly conical, somewhat curved downwards in lateral view.

	D.	V.
II	—	—
	0–1	0–1
III	—	2–3
	1–2	2–3
IV	—	—
	1–2	2
V	—	—
	2–3	2
VI	—	—
	3–4	2
VII	—	2
	4	3
VIII	—	
	4	

Larva.—Pronotum with slight medio-dorsal keel, obsolete posteriorly. Gills as in 1st table, all postsegmental except on segments 3 and 7 ventrally, where there are also presegmental gills. Head, pronotum, and mesonotal plates dark umber-brown. Legs brown. Abdomen creamy-white.

6·5–7 mm. Case 7–8 mm.

Pupa.—Dorsal plates on abdomen, with 2–3 spines, postsegmental plate on segment 5 transversely ovate, with eight spines. Gills as in 2nd table. 5–6 mm.

	D.	V.
II	—	
	1	
III	—	—
	1–2	1
IV		—
		1
V		—
		1–2
VI		—
		2–3

Localities.—River Zonder End Mts., 1500 feet (K. H. B., January 1919, ♂♂); Hottentots Holland Mts., 4000 feet (K. H. B. and H. G. Wood, January 1933, ♂♂, larvae, and pupae); Montagu Pass, George, 1000 feet (H. G. W., April 1933, larvae).

Remarks.—This is evidently the form whose larvae were recorded by Hagen as "*Trichostoma* sp." from Swellendam, and I name the species in honour of the first student of South African Caddis-cases.

The species is common in the streams on both sides of the Hottentots Holland Mts., on the west side being in the drainage system of the Lourens River, on the east side in that of the River Zonder End. The latter river joins the Breede River shortly before reaching Swellendam. Montagu Pass is in the Outeniqua Range, a continuation of the Langeberg Range, at the foot of which Swellendam is situated.

The pupal cases are fixed in the crevices of stones in the stream, usually several alongside one another or close together.

Rhoizema n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Occiput with interantennary tubercle small in ♂, well developed in ♀, and two small tubercles on hind margin. Antennae nearly ½ longer than fore-wing, 1st joint stout, especially in ♂, where it is furnished with a scent gland, 2nd joint short, 3rd 3–4 times length of 2nd. Maxillary palp in ♂ 1- or 2-jointed, 1st joint very stout, curved upwards, with long hairs on outer surface, dorsally with a process which may or may not bear a club-shaped, setose 2nd joint; where the 2nd joint appears to be absent the process itself is club-shaped and setose; in ♀ 1st joint short, 2nd and 4th subequal, 3rd slightly longer than 2nd, 5th half length of 3rd. Labial palp elongate in ♂, 1st and 3rd joints subequal, 2nd slightly longer; in ♀ shorter than maxillary palp, 2nd joint slightly shorter than 1st, 3rd slightly shorter than 2nd. Apical forks 1, 2, 5 in both wings in ♂, though 5 in fore-wing is really spurious; in ♀ forks 1, 2, 3, 5 in fore-wing, fork 3 sessile. Thyridial cell very long and distally broad in both wings. In fore-wing 1A obsolete distally (or fused with Cu_2) in ♂, but complete in ♀. Genitalia ♂, preanal appendages moderate, club-shaped, 9th sternite produced, apically excised or strongly bifurcate, penis simple, claspers 1-jointed; in ♀ a prominent chitinised supra-anal plate and a pair of dorso-lateral processes.

Larva.—Head short. Both mandibles with internal tuft. Pro- and mesonotum chitinised; metanotum membranous with a pair of small transverse plates. No prosternal spine. Fore leg stout; mid leg longer, slender; hind leg longest, slender. Dorsal tubercle on 1st abdominal segment present, lateral tubercles slightly chitinised. Lateral line on segment 8 only, where it is represented by a short series of minute bifid spinules directed dorsally. Gills small, usually simple, sometimes bifid or trifid, all presegmental. Anal holdfasts small.

Case tubular, slightly curved, composed of sand-grains, hind end closed with a membrane more or less covered with sand-grains and with a small circular aperture.

Pupa.—Labrum transversely ovate. Mandibles slender. Maxillary palp ♂ apically bifid, shorter than labial palp; in ♀ longer than labial palp. Fore tarsus slightly, mid tarsus strongly fringed. 1st abdominal segment dorsally with median chitinous thickening, very slightly projecting. Presegmental dorsal plates on segments 3–6 or 7, postsegmental also on segment 5. Gills presegmental and confined to the lateral and ventral surfaces. Anal appendages slender, rod-like, acute.

Case the same as that of larva, anchored to underside of, or between, stones, usually with a few larger sand-grains at both ends, hind end closed with a membrane with narrow vertical slit, front end with a membrane with slightly crescentic, horizontal narrow slit, with or without a small pebble covering mouth of tube.

Remarks.—The venation is somewhat like that of *Olinga*, but there is no fold in the fore-wing. The lateral appendages in the ♀ genitalia may possibly be homologous with the preanal appendages of the ♂. The supra-anal plate in ♀ appears in two forms: depressed and horizontal (*saxiferum*), or compressed and vertical (*spinosum* and *furciferum*).

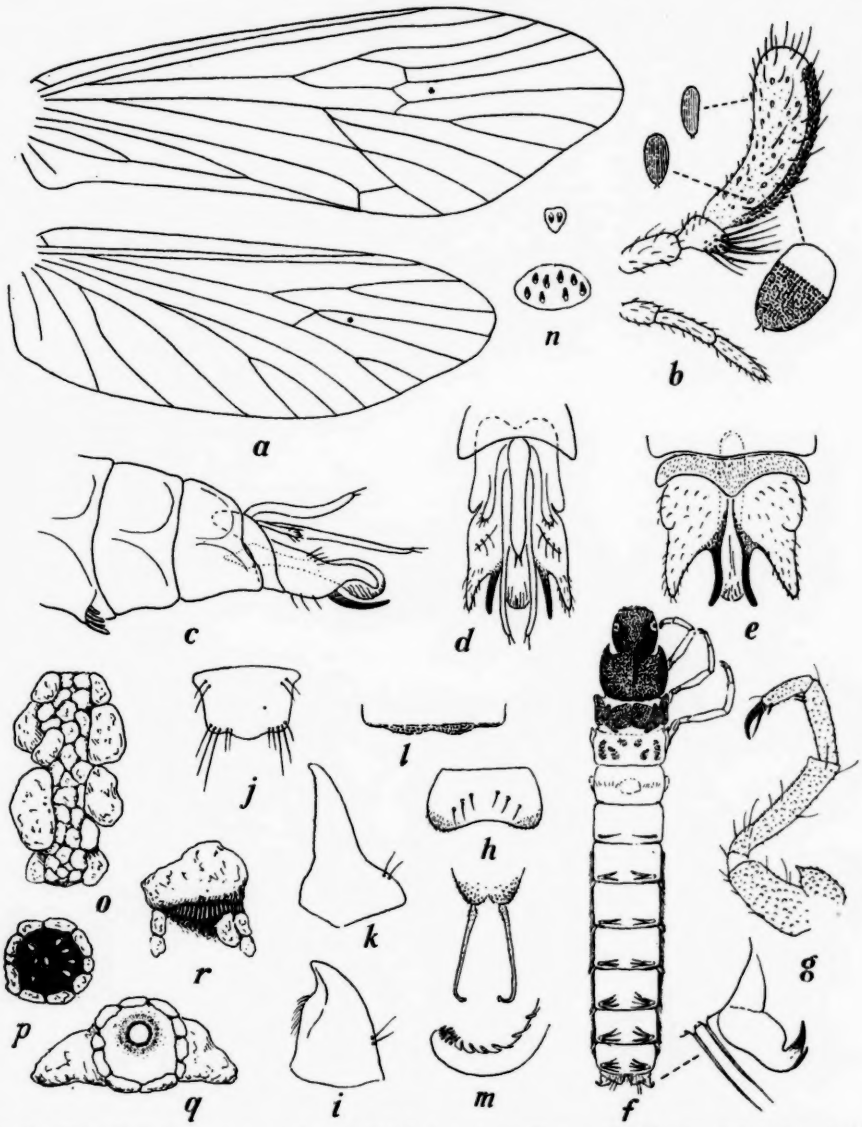

FIG. 6.—*Sinion hageni* n. g., n. sp. *a*, fore- and hind-wing; *b*, maxillary and labial palps of ♂; *c*, lateral view of 6th–8th abdominal segments and genitalia of ♂; *d*, *e*, dorsal and ventral views of genitalia of ♂; *f*, larva, with anal claw further enlarged; *g*, fore leg, with plaque d'appui; *h*, labrum of larva; *i*, mandible of larva; *j*, labrum of pupa; *k*, mandible of pupa; *l*, dorsal hind margin 1st abdominal segment of pupa; *m*, anal appendages of pupa, with apex further enlarged; *n*, dorsal plates of 5th abdominal segment of pupa; *o*, case; *p*, hind end of pupal case, lateral pebbles omitted; *q*, hind end of larval case; *r*, front end of pupal case to show lateral slit-like openings.

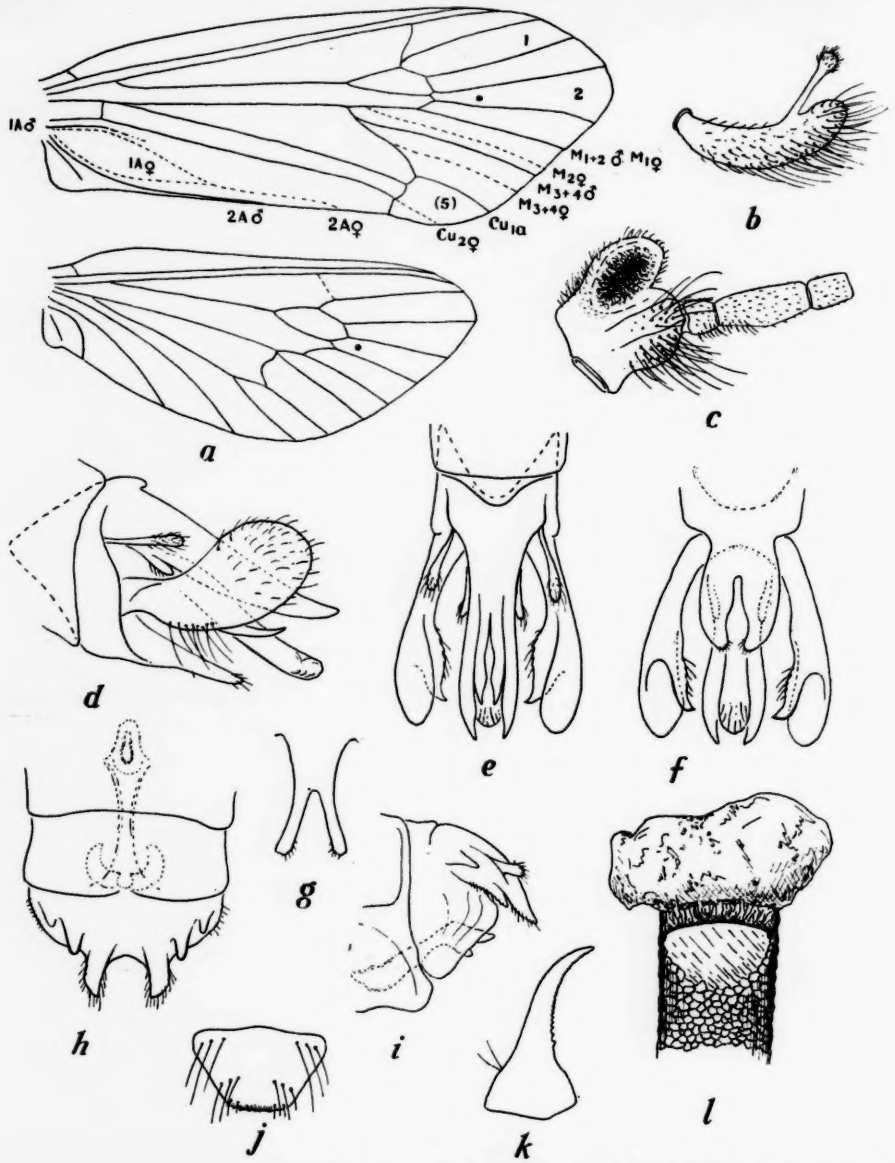

FIG. 7.—*Rhoizema saxiferum* n. g., n. sp. *a*, fore- and hind-wings ♂, with dotted lines indicating course of M_2, M_{3+4}, Cu_2, 1A and 2A in ♀; *b*, maxillary palp ♂; *c*, inner view of 1st–4th joints of antenna ♂, flap of scent gland open; *d*, *e*, *f*, lateral, dorsal, and ventral views of ♂ genitalia; *g*, aberrant form of 9th sternite ♂; *h*, *i*, dorsal and lateral views of ♀ genitalia; *j*, labrum of pupa; *k*, mandible of pupa; *l*, front end of pupal case, upper portion of tube cut away to show membrane and threads holding capping-stone in position.

The scent gland in the ♂ antenna consists of a fur-like mass in a pocket on the intero-dorsal surface of the first joint; the flap of the pocket can be closed.

When at rest the wings are folded, roof-like, over the abdomen, much more steeply than in *Dyschimus*.

Genotype: *R. saxiferum*.

Rhoizema saxiferum n. sp.

(Fig. 7.)

Imago.—Head and thorax testaceous with brown hairs. Antennae and palps fuscous. Legs fulvous. Wings pale brown, neuration slightly darker, fore-wing uniformly covered with greyish-brown pubescence, with slightly longer and denser hairs along R, M, and anal margin; hind-wing slightly paler grey. Maxillary palp ♂ 1-jointed, the process apparently unjointed, apically knob-like, setose. Genitalia ♂, 9th and 10th tergites fused, forming an upper penis sheath, on lower margin near base a small setose process on either side, apex deeply bifid; clasper with outer branch large, ovate, curving upwards, inner branch arising from lower surface about midway, forming a broad knife-like process with acute incurved strongly chitinised apex and setose inner margin; 9th sternite strongly produced, bilobed. ♀ supra-anal plate horizontal, with two submedian processes, the dorso-lateral processes simple.

Fore-wing ♂ 12–15 mm., ♀ 14–17 mm.

Larva.—See fig. 9 *a* of *spinosum*. Gills as in table for *furciferum*.

Up to 20 mm.

Head and other chitinised parts dark castaneous brown. Case up to 25 mm. in length, diameter at front end 5 mm.

Pupa.—Mandibles slender and evenly curved. Presegmental dorsal plates on segments 3–6, each with two spines, postsegmental plates on segment 5 with three spines. Gills as in table.

	L.	V.
II	1	2
III	2	3
IV	2	3
V	1	3
VI	1	3
VII	1	2
VIII	—	1

14–15 mm.

Case with front end closed by a small pebble in addition to the usual membrane, which is concentrically striate as in *spinosum*.

Localities.—Hottentots Holland Mts., 2500–4000 feet (K. H. B., 1917, 1 ♂, and January 1933, ♂♂, ♀♀, larvae, and pupae); Bain's Kloof, Wellington Mts. (K. H. B. and H. G. W., April 1933, cases and larvae); Bosch Kloof, Keeromberg (Worcester) (H. G. W., January 1933, 1 ♂).

Remarks.—The pupal cases, singly or in groups, are firmly anchored in crevices between stones and pebbles on the bottom of pools with the front half projecting. The imago emerges usually in the early morning (before 7 a.m.).

The front membrane has the usual crescentic slit, although it would seem to be nearly useless for aeration purposes owing to the attachment threads holding the capping-stone in position.

A single ♀ was bred (emerged 5/3/33) from larvae collected in the French Hoek Mts. (K. H. B. and H. G. W., December 1932). It corresponds with the ♀♀ from Hottentots Holland Mts., but in the absence of the ♂ the specific identity must be accepted with reserve. No capping-stone was placed on the mouth of the pupa case.

Rhoizema montanum n. sp.

(Fig. 8.)

Imago.—Head and thorax ochraceous with dark brown hairs. Antennae ochraceous, each joint in basal half with a narrow transverse dark band on upper surface extending down on either side but not continuous across ventral surface. Palps and legs fulvous. Wings pale brown, neuration slightly darker, uniformly covered with grey-brown pubescence.

Maxillary palp ♂ with 2nd joint arising from slender projection. Genitalia ♂, similar to those of *saxiferum*, 10th tergite apically cleft, and with a small ear-like lobe on either side; clasper with outer branch less ovate, inner branch more spiniform; 9th sternite produced, the truncate apex with a shallow excision. ♀ unknown.

	L.	V.
II	2	1
III	3	2
IV	3	2
V	2–3	2
VI	1	3
VII	—	3
VIII	—	1

Fore-wing 16 mm.

Pupa.—Mandibles slender, inner margin slightly arcuate. Presegmental dorsal plates on segments 3–6, each with 2–3 spines, postsegmental plates on segment 5 with 3–4 spines. Gills as in table.

18–19 mm.

Localities.—Robinson Pass (N. of Mossel Bay), 4000 feet (K. H. B. and H. G. W., February 1932, 1 ♂ and pupal skins); Montagu Pass (N. of George), 1000 feet (H. G. W., April 1933, 1 ♂). Both localities on the Outeniqua Range.

Remarks.—The 9th sternite of the Montagu Pass specimen is slightly more produced, with a deeper excision, about as deep as represented by the clear white space in fig. 8 *c*.

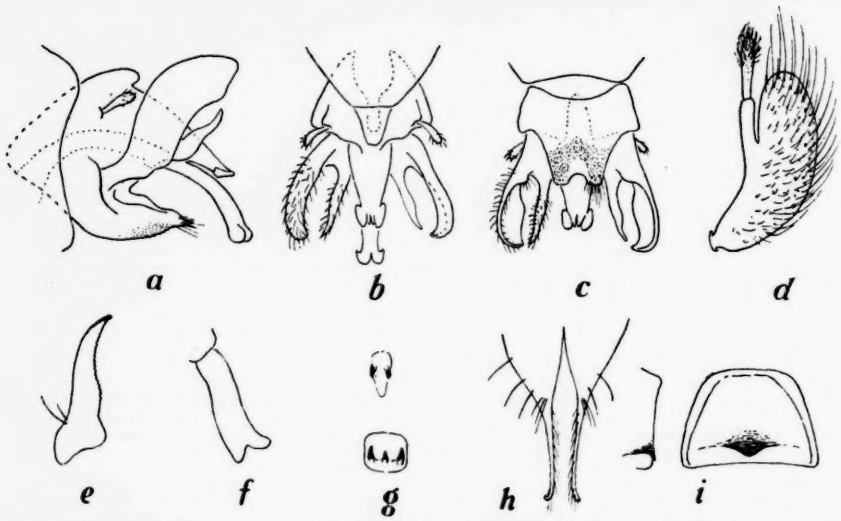

FIG. 8.—*Rhoizema montanum* n. sp. *a*, *b*, *c*, lateral, dorsal, and ventral views of ♂ genitalia; *d*, maxillary palp ♂; *e*, mandible of pupa; *f*, maxillary palp of ♂ pupa; *g*, dorsal plates of 5th segment of pupa; *h*, anal appendages of pupa; *i*, lateral and dorsal views of 1st abdominal segment of pupa.

Rhoizema spinosum n. sp.

(Fig. 9.)

Imago.—Head and thorax testaceous with golden-brown hairs. Antennae, palps, and legs ochraceous. Wings pale brown, fore-wing uniformly covered with greyish or pale brown pubescence, hind-wing paler grey.

Maxillary palp ♂, 2nd joint very short, club-shaped, arising from a scarcely perceptible process on 1st joint. Genitalia ♂, fused 9th and 10th tergites elongate, bearing proximally a pair of elongate slender spines, and distally a pair of stout recurved chitinised spines (sometimes also an additional subapical pair of minute spines), apex cleft; clasper oblong, spoon-like (concave on inner surface), with a strong chitinous point arising from lower inner margin; 9th sternite broad, projecting apices widely divergent. ♀ supra-anal plate laterally compressed, projecting, dorsally grooved and apically bifid, dorso-lateral processes bifurcate.

Fore-wing ♂ 11–12 mm., ♀ 12–13 mm.

Larva.—See fig. 9 *a*. Gills as in 1st table.

	D.	L.	V.
I	1	—	—
II	1	1	1
III	2	1	1–2
IV	1	1	2–3
V	—	1	2
VI	—	1	2
VII	—	1	1

	L.	V.
II	—	3
III	—	3
IV	1	3–4
V	1	3–4
VI	1	3–4
VII	1	2–3
VIII	—	1–2

Up to 23 mm.

Case up to 27 mm. Hind end slightly convex, closed with sand-grains, leaving a small circular aperture.

Pupa.—Mandibles shorter and less slender than in *saxiferum*, inner margin arcuate. Presegmental dorsal plates on segments 3–6 each with two spines, postsegmental plates on segment 5 with two spines. Gills as in 2nd table.

14–15 mm.

Case without capping-stone at front end.

Locality.—River Zonder End Mts., 1500 feet (H. G. W., December 1931, larvae; and January 1933, ♂♂, ♀♀, pupal skins); Witte River, Wellington Mts. (H. G. W., January 1934, ♂ ♀).

Rhoizema furciferum n. sp.

(Fig. 10.)

Imago.—Head and thorax testaceous with pale ochraceous or golden hairs. Antennae pale ochreous, with darker annulations. Palp and legs pale ochreous. Wings ochraceous, neuration scarcely darker, fore-wing covered with pale golden pubescence, rather more greyish in ♂, more yellowish in ♀, hind-wing greyish. Maxillary palp ♂, with 2nd joint arising from a short, collar-like projection. Genitalia ♂, 9th and 10th tergites fused into a long, slender, pointed process, apically cleft, and bearing near apex an upturned, bifurcate process on either side; clasper nearly straight, cylindrical, apically truncate, outer distal angle pointed,

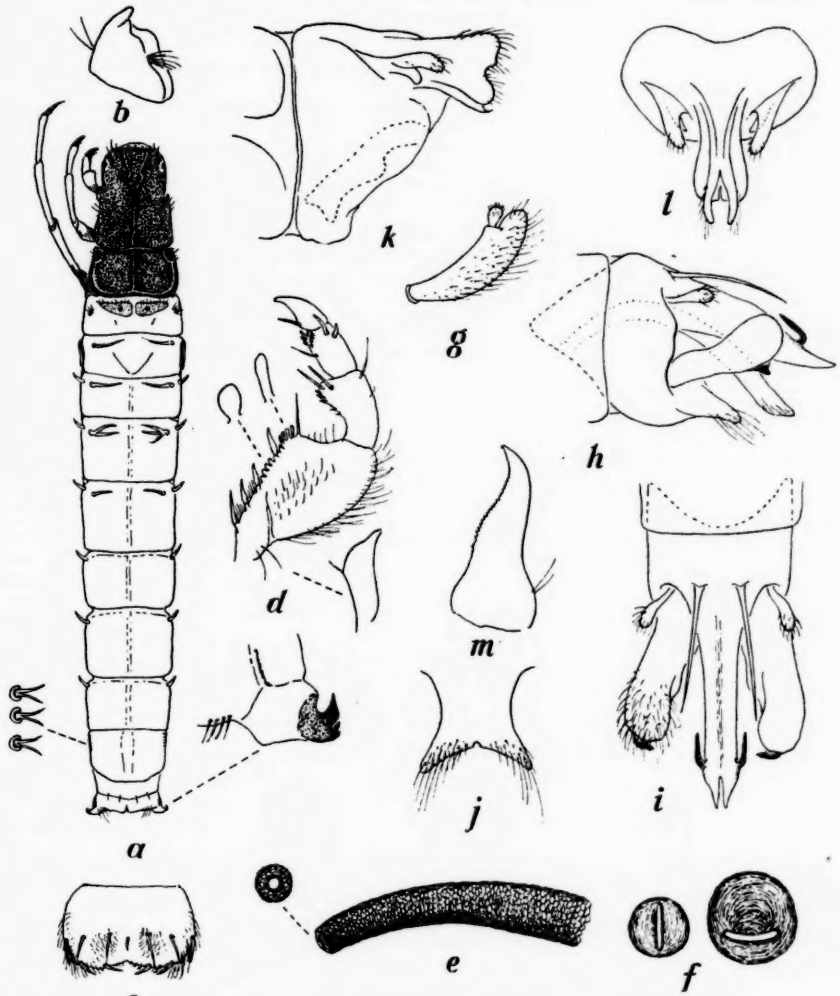

FIG. 9.—*Rhoizema spinosum* n. sp. *a*, larva, with anal claw and spinules on segment 8 further enlarged; *b*, *c*, mandible and labrum of larva; *d*, fore leg, with plaque d'appui of larva; *e*, larval case; *f*, membranes from hind and front ends of pupal case; *g*, maxillary palp ♂; *h*, *i*, lateral and dorsal views of ♂ genitalia; *j*, 9th sternite ♂; *k*, *l*, lateral and dorsal views of ♀ genitalia; *m*, mandible of pupa.

inner distal angle with two denticles, a curved spinous process on lower inner margin (not shown in dorsal view, fig. 10 *b*); 9th sternite produced, bifurcate, the lobes divergent and apically subacute. ♀ supra-anal plate compressed, projecting, dorsally grooved, apically bifid, dorso-lateral processes bifid.

	D.	L.	V.
I	1	—	—
II	2	1	2
III	2–3	1	2
IV	—	—	2
V	—	—	2
VI	—	—	2
VII	—	—	1
VIII	—	—	0–1

	L.	V.
II	—	1
III	1	3
IV	1	2
V	1	2
VI	1	2
VII	1	1–2
VIII	—	1

Fore-wing ♂ 11 mm., ♀ 12–13 mm.

Larva.—Cf. fig. 9 *a*. Gills as in 1st table.

Up to 14 mm.

Case with hind end flat, not convex, closed by a membrane without sand-grains.

Pupa.—Mandibles as in *spinosum*. Presegmental dorsal plates on segments 3–6, each with two spines, postsegmental plates on segment 5 with 2–3 spines; 7th segment with minute presegmental plates without any spines. Gills as in 2nd table.

11–13 mm.

Case without capping-stone at front end; both front and hind membranes with radiating crinkly striae or corrugations.

Localities.—Lemoenshoek, Langeberg Range (K. H. B., November 1927, 1 ♂); French Hoek Pass (E. side) (K. H. B. and H. G. W., December 1932, ♂♂, ♀♀, larvae, and pupae); Bosch Kloof, Keeromberg (Worcester) (K. H. B., January 1930, pupal skin, and H. G. W., January 1933, 1 ♀, pupal cases).

Remarks.—The pupal cases are fixed to the undersides of stones, usually with two or three larger sand-grains at both ends. Similar pupal cases, which are smaller than those of the other species, have been found in the Hottentots Holland Mts., Wellington Mts., Jonkershoek, and Du Toit's Kloof (Rawsonville); but without imagos it would not be safe to ascribe these definitely to this species.

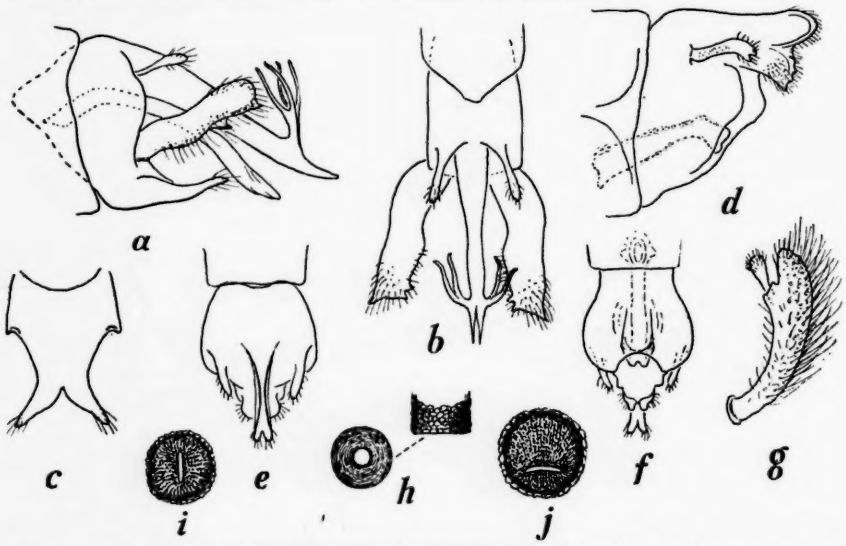

FIG. 10.—*Rhoizema furciferum* n. sp. *a*, *b*, lateral and dorsal views of ♂ genitalia; *c*, 9th sternite ♂; *d*, *e*, *f*, lateral, dorsal, and ventral views of ♀ genitalia; *g*, maxillary palp ♂; *h*, hind end of larval case, with membrane; *i*, *j*, membrane from hind and front ends of pupal case.

Aselas n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Antennae not quite as long as fore-wing, basal joint not very stout. Maxillary palp ♂, consisting of a single bulbous joint, with a pocket on outer distal surface, in which lies partly concealed a very thick tuft of deep brown hairs. Accessory structures on the palp, and also between palp and antenna close to front margin of eye. Labial palp, 2nd joint twice 1st, considerably more slender, 3rd not quite as long as 2nd. In fore-wing apical forks 1, 2, 3, 5. Cu_2 and 1A not reaching margin. In hind-wing apical forks 1, 2, 5, 1 shortly stalked, 2 with very short stalk. Discoidal cell closed. Genitalia ♂, preanal appendages absent or represented by slight protuberances bearing hairs, 10th tergite cleft, 9th sternite produced in a median process, claspers 1-jointed, biramous. ♀ unknown.

Remarks.—This form is remarkable for the complicated structure of the maxillary palp. As will be seen in the figure, there is a terminal bifid process, the smaller branch of which is tipped with spinules, and the larger carries a number of long hairs, each of which arises from a little pedicel. Between the base of the maxillary palp and the antenna there is another process bearing long hairs on pedicels.

Aselas camella n. sp.

(Fig. 11.)

Imago.—Head and thorax ochraceous with pale golden hairs. Legs and antennae ochraceous. Wings pale ochraceous with somewhat dull or greyish-gold hairs.

Fore-wing 6–6·5 mm.

Genitalia ♂, 10th tergite broad at base, narrowing to two fine points, process of 9th sternite stout, club-shaped, claspers divided into two branches, the upper and outer apically curved inwards and ending in a chitinous point, the lower and inner more slender.

Locality.—Oudebosch, River Zonder End Mts., 1500 feet (K. H. B., January 1919, 1 ♂; H. G. W., January 1933, 1 ♂).

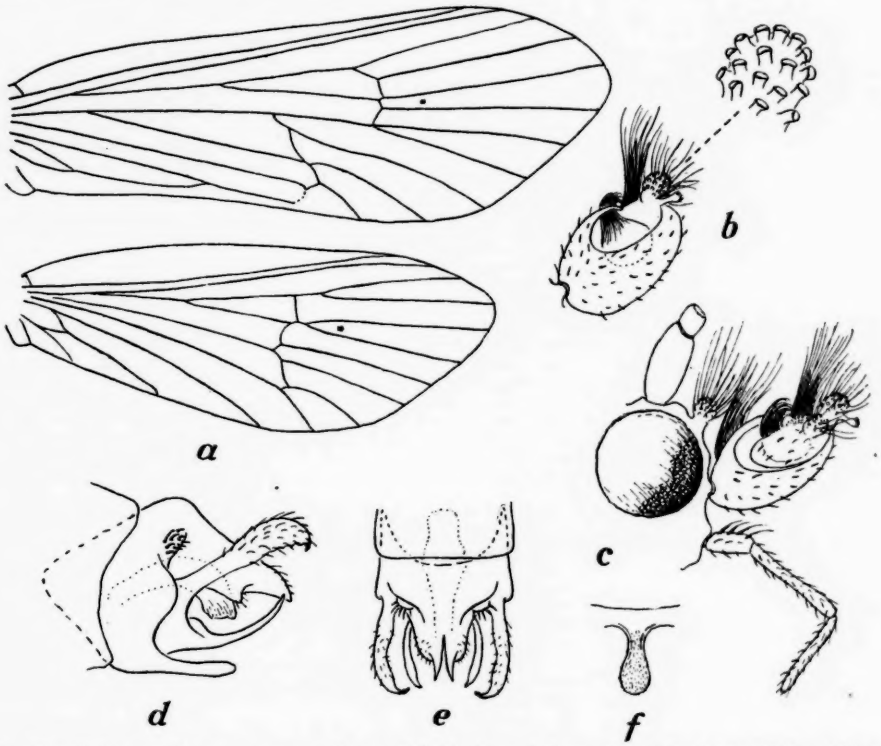

FIG. 11.—*Aselas camella* n. g., n. sp. *a*, fore- and hind-wings; *b*, inner view of 1st joint of left maxillary palp ♂; *c*, outer view of front of head, with base of antenna, maxillary and labial palps (right); *d*, *e*, lateral and dorsal views of ♂ genitalia; *f*, 9th sternite.

Cheimacheramus n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Interantennary tubercle small. Antennae slightly shorter than fore-wing, basal joint stout, bulbous on inner side, almost as broad as long. Labrum broader than long, semi-circular. Maxillary palp ♂, consisting of a single stout cylindrical joint curved upwards in front of face, bearing long hairs on its outer surface. Labial palp moderately long, 2nd joint very slightly longer than 1st, which is subequal to 3rd. Fore-wing with apical forks 1 and 2 in both sexes, in ♀ forks 3 and 4 also present; 5 absent as Cu_1 ends in Cu_2. In hind-wing apical forks 1, 2, 5 in both sexes; discoidal cell open. Genitalia ♂, elongate, preanal appendages club-shaped, claspers 1-jointed.

Larva (portions extracted from pupal case).—Mandible with internal tufts. Clypeus elongate (see fig. 12 *g*). Anal claw strong, bi-uncinate.

Pupa.—Labrum subtriangular. Mandible straight, inner edge minutely serrulate. Mid tarsi fringed. Dorsal plates presegmental on segments 3–6, and postsegmental on segment 5. Anal appendages rod-like, straight, with two subterminal setae and two very long terminal setae. No gills or lateral line.

Case tubular, curved, composed of very minute sand-grains, the interstitial cement thick and black, giving the whole case a dark sepia or blackish colour. Posterior and anterior ends squarely truncate, the former closed by an operculum with circular central opening, the latter by one with excentric narrow oval opening, outer surface of latter with faint subconcentric and subradial striae. Near hind end a thin septum with narrow central transverse slit. Affixed to rocks by a tough silken flap on either side of the mouth (occasionally only one flap). 14–16 mm.

Remarks.—The generic name from the "Snowhole" or Sneeuwgat Valley in the Gt. Winterhoek Mts.

Cheimacheramus caudalis n. sp.

(Fig. 12.)

Imago.—Head and thorax dark castaneous brown, with light golden-brown hairs. Legs and antennae fuscous. Wings brown with golden-brown hairs, fringes sepia.

Fore-wing 8 mm. (Gt. Winterhoek), 5–5·5 mm. (Tradouw).

Genitalia ♂, dorsal process (10th tergite) elongate, widely forked at apex; claspers with two upstanding processes on upper margin, the proximal one broad, the distal one narrow and bent further inwards; 9th sternite with blunt median triangular projection; penis with wing-like expansion before the apical expansion; ♀, see fig. 12 *e–g*.

Pupa.—Two crotchets on each dorsal plate (pre- and postsegmental). 8–9 mm.

Localities.—Gt. Winterhoek Mts., Tulbagh, 4500 feet (K. H. B. and R. M. Lightfoot, November 1916, ♂♂, ♀♀; and K. H. B., November 1932); Tradouw Pass, Langeberg Range, near Swellendam (K. H. B., October 1925, ♂♂); Palmiet River (H. G. W., December 1933, ♂♂, ♀♀).

Remarks.—Although the Tradouw Pass specimens are considerably smaller, they do not differ in the genitalia, and only slightly and unessentially in the venation, from the Gt. Winterhoek specimens.

Cases with pupae nearly ready to hatch, and thus affording correlation with the fly, were found in the Gt. Winterhoek Mts. in November 1932.

Petroplax n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Antennae as long as fore-wing, basal joint stout. Maxillary palp ♂ very short, upturned, composed of two joints, the first bulbous with a small terminal pedicel to which is attached the very small 2nd joint, both joints with thickened setae; in ♀ long, 1st and 3rd joints subequal, 2nd longest, 4th and 5th subequal, slightly shorter than 1st or 3rd joints. Labial palp moderate, in ♀ half the length of maxillary palp, or a little longer than half, the joints subequal, in ♂ longer and more slender than in ♀. In fore-wing apical forks 1, 2, 5, in ♀ also fork 3, *i.e.* M simple in ♂, forked in ♀. Thyridial cell very long. 1A and 2A in ♂ joining distally near hind margin, in ♀ proximally. No cross-vein between Cu_2 and 1A in ♀. In hind-wing forks 1, 2, 5. Discoidal cell open. Genitalia ♂, preanal appendages short, club-shaped; claspers 1-jointed, apically bifurcate; 9th sternite with two widely separated processes; penis with a pair of subapical, mobile spiniform processes; a projecting lamina on 7th sternite. In ♀ a projecting supra-anal plate and strongly chitinised vulva.

Larva.—Mandibles with internal tufts, but feeble in left mandible. No prosternal spine. Mesonotum less strongly chitinised than pronotum, metanotum membranous. Hind leg longest. Dorsal tubercle on abdomen segment 1 obsolete. Simple, presegmental gills on segments 2–8, lateral and ventro-lateral. Lateral line visible only on segment 8. Anal holdfasts small.

Case tubular, widening slightly towards mouth, composed of fine sand-grains, with a few larger grains at both ends.

Pupa.—Labrum nearly as long as broad, rounded. Mandible strong, serrulate on inner margin. Mid tarsus fringed. First abdominal segment with transverse thickening, followed by a band of minute scabrosities. Gills as in larva. Lateral line feeble. Presegmental dorsal plates on segments 3–6, postsegmental also on segment 5, the latter smaller than former. Anal appendages lanceolate, apices acute and upturned.

Case the same as that of larva, anchored fore and aft to stones by silken threads; front end closed with sand-grains, leaving a small, narrow horizontal slit; hind end closed with sand-grains, leaving a narrow slit (the pupa lies with its ventral surface towards the concave side of the case, and the slit at hind end is vertical or dorso-ventral).

Remarks.—Two variations in neuration have been observed. In one Table Mt. ♀ there are only two branches of M, fork 3 therefore being absent. In one Montagu ♀ fork 3 is shortly stalked.

The generic name is taken from the Flat Rock or Platteklip stream, where one of the species, together with its larva and pupa, was found.

Genotype: *P. caricis* n. sp.

Petroplax caricis n. sp.

(Figs. 13 and 1 *c*.)

Imago.—Head and thorax castaneous brown with bright, pale golden hairs. Antennae dark brown, with narrow pale annulations. Legs pale brown, tarsi annulate. Wing membrane brown, darker in ♂ than ♀ (usually), neuration darker, the anastomosis and a streak along M in fore-wing conspicuously white or clear, portions of M and Cu_2 in hind-wing also clear, but less conspicuous. Fore-wing with pale golden pubescence, the anastomosis paler, hind-wing with sepia pubescence, fringes whitish-grey. Abdomen sepia, paler along sides; in ♂ the plate on 7th sternite pale, the genitalia testaceous, preanal appendages blackish.

Fore-wing ♂ 5–6 mm., ♀ 6·5–7 mm.

Genitalia ♂, 9th and 10th tergites fused, apically deeply cleft, apices acute, a pair of small elongate low tubercles proximal to the cleft, which in some localities may be conical tubercles or short spines; penis with

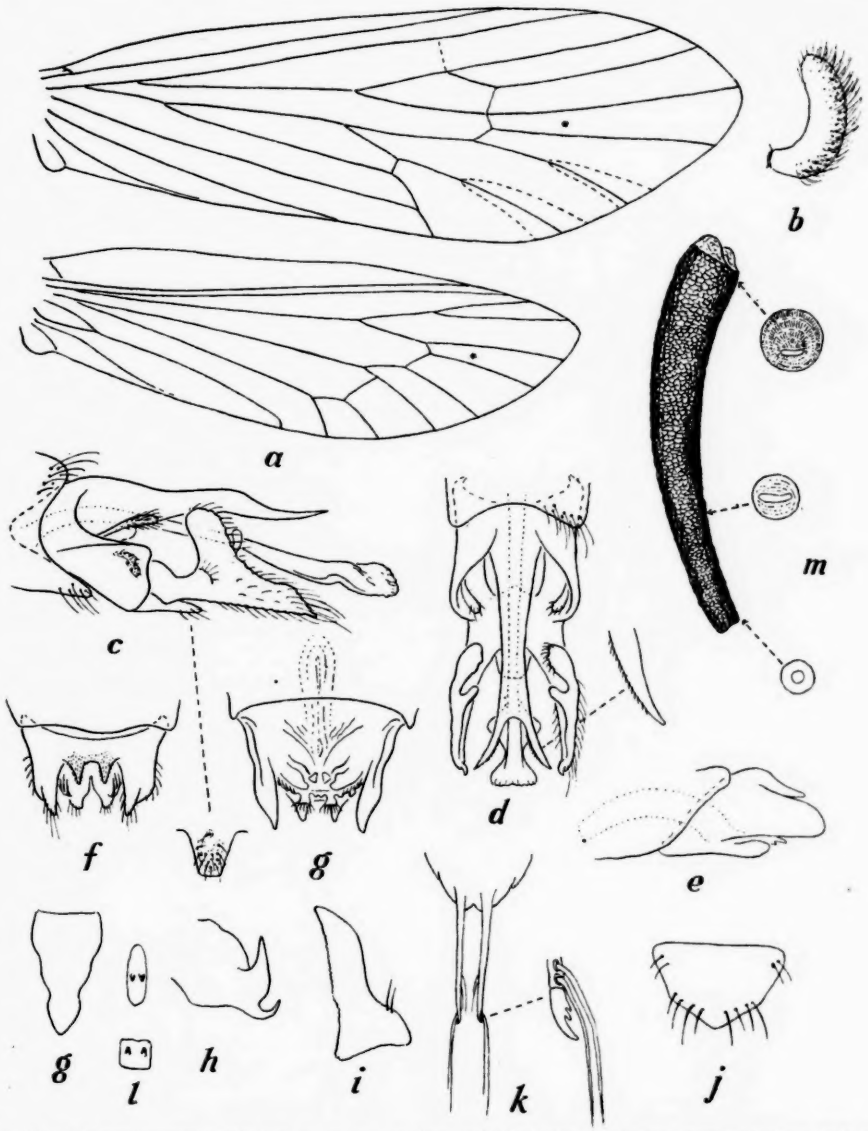

FIG. 12.—*Cheimacheramus caudalis* n. g., n. sp. *a*, fore- and hind-wings ♂, dotted lines indicating forks 3 and 4 in ♀; *b*, maxillary palp ♂; *c*, *d*, lateral and dorsal views of ♂ genitalia, with ventral view of 9th sternite; *e*, *f*, *g*, lateral, dorsal, and ventral views of ♀ genitalia; *g*, clypeus of larva; *h*, anal claw of larva; *i*, mandible of pupa; *j*, labrum of pupa; *k*, anal appendages of pupa; *l*, dorsal plates of 5th segment of pupa; *m*, pupal case, with membranes.

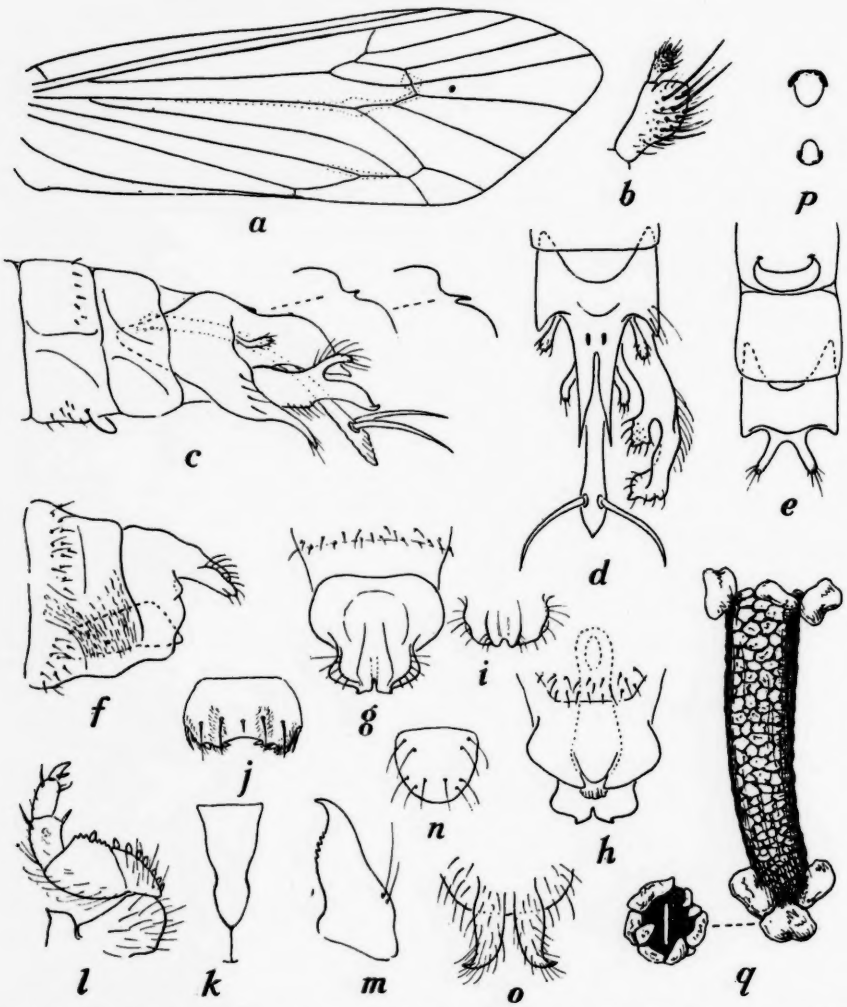

FIG. 13.—*Petroplax caricis* n. g., n. sp. *a*, fore-wing ♂, dotted lines indicate hyaline areas on membrane; *b*, maxillary palp ♂; *c*, *d*, lateral and dorsal views ♂ genitalia, with variations of the dorsal profile of 9th and 10th tergites; *e*, ventral view of segments 7–9 ♂; *f*, *g*, *h*, lateral, dorsal, and ventral views ♀ genitalia; *i*, dorsal view of supra-anal plate of ♀ from Elands Kloof; *j*, *k*, labrum and clypeus of larva; *l*, fore leg of larva; *m*, *n*, mandible and labrum of pupa; *o*, anal appendages of pupa; *p*, dorsal plates of 5th segment of pupa; *q*, pupal case.

two long, spiniform, evenly tapering processes; clasper with both branches turned inwards, lobate; 9th sternite with relatively short processes; lamina on 7th sternite transverse, crescentic. ♀ supra-anal plate shortly cleft, apices truncate, dorsal surface with setose ridge subparallel to outer margin.

Larva.—Plaque d'appui oblong, truncate, with slightly upturned point. Bases of legs with numerous long silky hairs. Abdomen ending in two ovate lobes with black hairs and spinules. One ventro-lateral gill on each of segments 2–8, 1 smaller lateral one on segments 4–7. Head testaceous, pronotum and mesonotum gradually paler. Abdomen white.

Up to 7–8 mm.

Pupa.—Pre- and postsegmental dorsal plates each with two crotchets.

7–8 mm.

Case about 7–8 mm., diameter at mouth 2 mm., at hind end 1·5 mm.

Localities.—Table Mt., Cape Peninsula, 500 feet (K. H. B., November 1932, and February-March 1933, ♂♂, ♀♀, larvae, pupae; and H. G. W., February-March 1933, ♂♂); Muizenberg, Kalk Bay, and Glencairn Mts., Cape Peninsula (K. H. B., December 1932, ♂♂); Seven Weeks Poort Berg, Zwartberg Range, 5000 feet (K. H. B., December 1928, 1 ♂); River Zonder End Mts., 1500 feet (H. G. W., January 1933, ♂, ♀); French Hoek (K. H. B. and H. G. W., December 1932, ♂♂, ♀♀); Groot Drakenstein (A. C. H., September 1930, pupae).

Remarks.—Sits with wings folded roof-like, and antennae stretched out straight in front, on vegetation along margins of streams, preferably (in the Platteklip stream, Table Mt.) on the leaves of *Carex*.

A ♀ from Elands Kloof, Citrusdal (H. G. W., March 1933), has the apices of the supra-anal plate rounded, not truncate (fig. 13 *i*).

Petroplax phleophila n. sp.

(Fig. 14 *a–g.*)

Imago.—Colour as in *caricis*, but wings paler.

Fore-wing 7 mm.

Genitalia ♂, 10th tergite shorter than in *caricis*, apically shortly cleft, apices blunt, with a small subterminal point on either side; penis with two arcuate, rather stout subterminal processes; clasper with upper branch lobate, lower branch apically acute, incurved; 9th sternite with rather long process; lamina on 7th sternite narrower but longer than in *caricis*. ♀ supra-anal plate deeply cleft, lobes apically rounded, each with a median upstanding keel dorsally.

Localities.—Witte River, Wellington Mts., 3500 feet (K. H. B., November 1922, ♀); Montagu (K. H. B., November 1919, ♀♀); Palmiet River (H. G. W., December 1932, ♂♂, ♀♀).

Petroplax prionii n. sp.

(Fig. 14 *h–l.*)

Imago.—Head and thorax dark blackish-brown with pale golden hairs. Legs fuscous, tarsi annulate. Antennae fuscous, with narrow pale annulations. Wing membrane sepia, neuration darker with clear areas as in *caricis*, fore-wing with pale golden or greyish pubescence, hind-wing with sepia pubescence.

Fore-wing ♂ 6 mm., ♀ 6–6·5 mm.

Genitalia ♂, fused 9th and 10th tergites apically deeply cleft, apices acute, lower lateral margin with a few fine serrations and setae, dorsally with a pair of low tubercles, and laterally a projecting acute point, surface around tubercles minutely scabrous; penis with short uncinate subterminal processes; clasper with upper branch narrowly lobate, lower branch incurved, apex acute, a brush of strong spines on middle of lower inner margin; 9th sternite with rather long processes; lamina on 7th sternite transverse, crescentic. ♀ supra-anal plate somewhat similar to that of *phleophila*, but cleft wider.

Locality.—Jonkershoek, Stellenbosch (K. H. B. and H. G. W., February 1933, ♂♂, ♀♀).

Remarks.—Obtained by sweeping the palmiet (*Prionium*) and other vegetation along the banks of the river.

Barbarochthon n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Interantennary tubercle not prominent. Antennae as long as fore-wing, basal joint moderately and equally stout in both sexes. Maxillary palp ♂ about as long as labial palp, 1st and 2nd joints moderate, 3rd nearly equal to 1st and 2nd together, moderately stout, thickly covered with hairs; in ♀ longer than labial palp, 1st and 3rd joints subequal, 2nd slightly longer, 4th and 5th subequal, each slightly shorter than 3rd. Labial palp moderate, 2nd and 3rd joints subequal, each slightly longer than 1st. In fore-wing apical forks 1, 2, 3, and spurious 5 in both sexes, fork 3 stalked. In hind-wing venation very anomalous, R united with Sc in ♂, feebly developed in ♀; no discoidal cell; fork 1 in ♂, forks 1 and 2 in ♀; some veins obsolete proximally. Genitalia ♂, preanal appendages short, bifid, 10th tergite deeply cleft, claspers 1-jointed.

Larva.—Head dorsally flattened. Mandibles stout, both with internal tufts. Pronotum corneous; mesonotum also but less strongly chitinised in hinder half; metanotum short, membranous, with minute chitinised plates. Fore leg stout, hind leg longest; plaque d'appui bluntly conical. No prosternal spine. Lateral line very feeble. Gills not observed, if present very minute. Anal holdfasts short.

Case cylindrical, slightly curved, composed of silken secretion in which very minute sand-grains are incorporated in varying number, sometimes very numerous, especially proximally, sometimes very sparse. Hind end closed with membrane with central circular aperture.

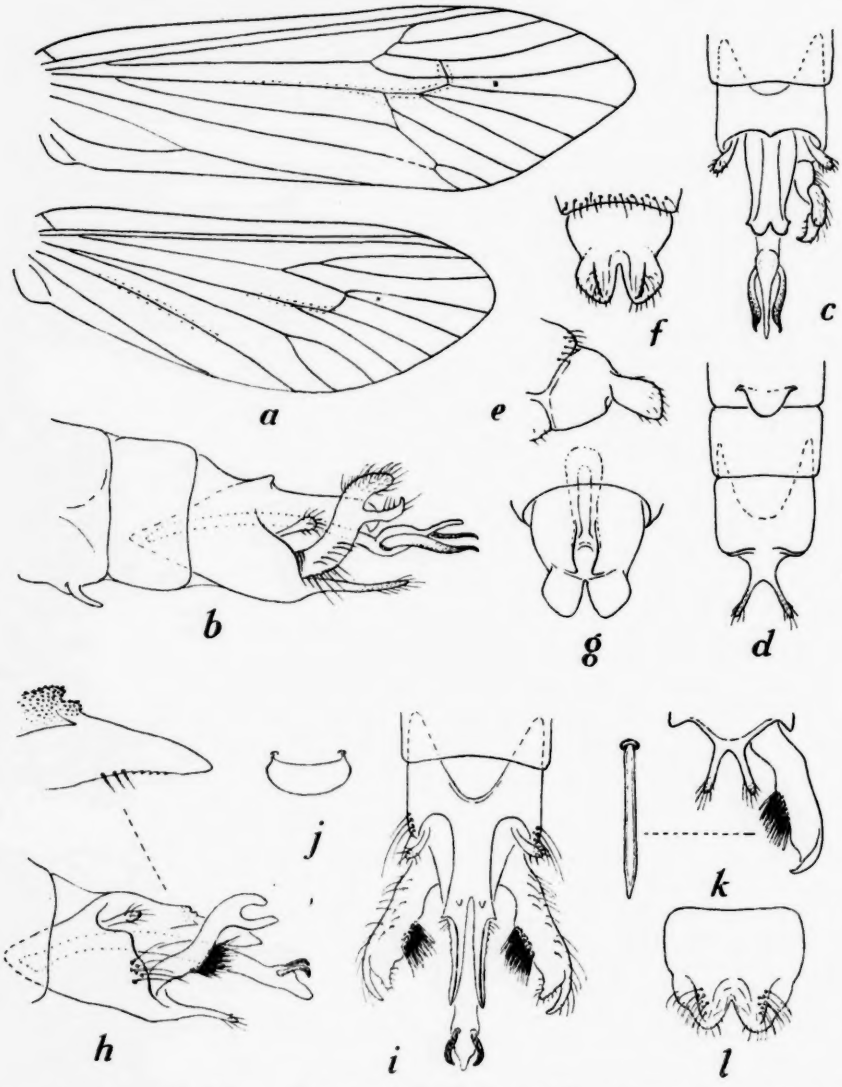

FIG. 14.—*Petroplax phleophila* n. sp. *a*, fore- and hind-wings ♀, dotted lines indicate hyaline areas on membrane; *b*, *c*, lateral and dorsal views of ♂ genitalia; *d*, ventral view of 7th–9th sternites ♂; *e*, *f*, *g*, lateral, dorsal, and ventral views of ♀ genitalia. *Petroplax prionii* n. sp. *h*, *i*, lateral and dorsal views of ♂ genitalia with 10th tergite further enlarged; *j*, ventral lamina on 7th segment ♂; *k*, ventral view of 9th sternite ♂, with spine from clasper further enlarged; *l*, dorsal view of ♀ genitalia.

Pupa.—Labrum transversely ovate. Mandibles slender, falcate. Mid tarsus fringed. Abdominal segment 1 unarmed. Presegmental dorsal plates on segments 2–6, postsegmental also on segment 5. Lateral line feeble. Gills absent. Anal appendages slender, rod-like.

Case the same as that of larva, but shortened by the cutting off, or breaking off, of a portion of the hind end, attached to underside of stones by an adhesive disc, hind end closed by membrane with dorso-ventral (vertical) oval aperture, front end closed by convex membrane with horizontal narrow slit.

Remarks.—The early Dutch colonists referred to the range of mountains where this insect was caught as the "Holland" or Home of the Hottentots; hence the generic name.

The shortening of the pupal case appears to be accidental, as cases are frequently found in which the slender hind end is retained; when this occurs the membrane at hind end of pupa is an internal septum, as in *Cheimacheramus*.

Barbarochthon brunneum n. sp.

(Figs. 15 and 1 *a*.)

Imago.—Head and thorax dark sepia-brown with paler hairs. Legs and antennae fuscous. Wings brown with pale hairs. Membrane with a clear patch on upper margin of thyridial cell and the cross-vein between R_5 and M, and a spot on the connecting vein between Cu_1 and Cu_2 (? = lower branch of Cu_1).

Fore-wing ♂ 5–6 mm., ♀ 6·5–7 mm.

Genitalia ♂, preanal appendages bifid, the inner apex with two points or spinules, the outer spinulose; 10th tergite deeply cleft, forming two slender processes; clasper simple, flattened, apically subacute, turned downwards and inwards, setose; penis apically divided into a dorsal, apically bifid, lobe and a ventral lobe. ♀ with short, overhanging supra-anal plate.

Larva.—Head and pronotum blackish-brown, pigment arranged in a honeycomb manner. Mesonotum brown anteriorly, pale posteriorly, with darker spots as in fig. 15 *i*. Metanotum and abdomen creamy-white.

Up to 8 mm.

Pupa.—6·5–7·5 mm.

Localities.—Hottentots Holland Mts., 3500–4000 feet (K. H. B., January 1916, 1 ♂; and K. H. B. and H. G. W., January 1933, ♂♂, ♀♀, larvae, and pupae); Wellington Mts., 3000 feet (K. H. B., November 1922, 1 ♂); Table Mt., Cape Peninsula, 1000 feet (K. H. B., 1st March 1933, 1 pupa, empty cases); Montagu Pass, N. of George, Outeniqua Range (H. G. W., April 1933, larvae).

Remarks.—In the Wellington specimen, and in some from the Hottentots Holland Mts., the preanal appendages are scarcely bifid, the smaller lobe being very obscure, and the 10th tergite is not quite so deeply cleft (about ¾ of length). The lower inner angle of the claspers are either rounded (as figured) or square, sometimes with a small sharp point. The claspers may be more slender than represented in the lateral view.

Slight variations occur also in the shape of the discoidal cell in fore-wing, which may be 4-, 5-, or 6-sided, with consequent variation in the width of the base of forks 1 and 2; where the discoidal cell is 4-sided fork 1 arises from its apex.

AEQUIPALPIA.

The following two genera belong to this section, and both might be included in the neighbourhood of the *Molannidae–Beraeidae* but for the presence of a discoidal cell in the fore-wing. For the present I refrain from expressing any opinion as to their true position.

Hydrosalpinx n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Antennae slightly longer than fore-wing, rather stout. A conical wart behind base of each antenna. Maxillary palp 5-jointed ♂ ♀, very long in ♂, 1st and 2nd joints very short, 3rd about equal to 1st and 2nd together, 4th about three times as long as 3rd, 5th a little longer. Labial palp in ♂ long, 1st joint very short, 2nd long, 3rd a little longer; in ♀ half the length of maxillary palp. Terminal joints in both palps unsegmented. Fore-wing with apical forks 1, 2, 3, 5, fork 5 being spurious in ♂ (owing to Cu_1 not being forked), fork 1 sessile, forks 2 and 3 stalked, discoidal cell short but broad, thyridial cell very long. In hind-wing ♂ costal area very broad proximally, R developed only in basal half, only fork 2 present, M and Cu_1 simple; no discoidal cell, no cross-veins; in ♀ R complete, joining Sc at the margin, forks 1 and 2 present, the latter sessile, discoidal cell closed (the cross-vein sometimes very obscure), M forked, Cu_1 simple. Genitalia ♂, preanal appendages strongly developed, penis without titillators, claspers bifid, lower branch broadly lobate, upper branch elongate, slender; ♀ terminal tergite with bilobed and slightly projecting apex, sternite with numerous striae or corrugations.

Larva.—Head slightly longer than broad. Both mandibles with internal tufts. Pronotum corneous; mesonotum also corneous, but not so strongly chitinised. Metanotum very short, membranous, with two feebly chitinised transverse plates. No prosternal spine. Fore leg stout, hind leg longest, but not extending much beyond middle leg. Femora of one piece. Lateral line feeble. Gills absent. Anal holdfasts short.

Case tubular, slightly curved, often slightly expanded or trumpet-shaped at mouth, composed entirely of silken secretion. Hind end with small circular aperture.

Pupa.—Antennae slightly longer than body. Labrum semi-circular, with short median lobe. Mandibles stout, on broad bases, inner margin strongly dentate. Maxillary and labial palps in ♂ very long, both extending nearly to apices of mid coxae; in ♀ the former extending to middle of mid coxae, the latter half as long.

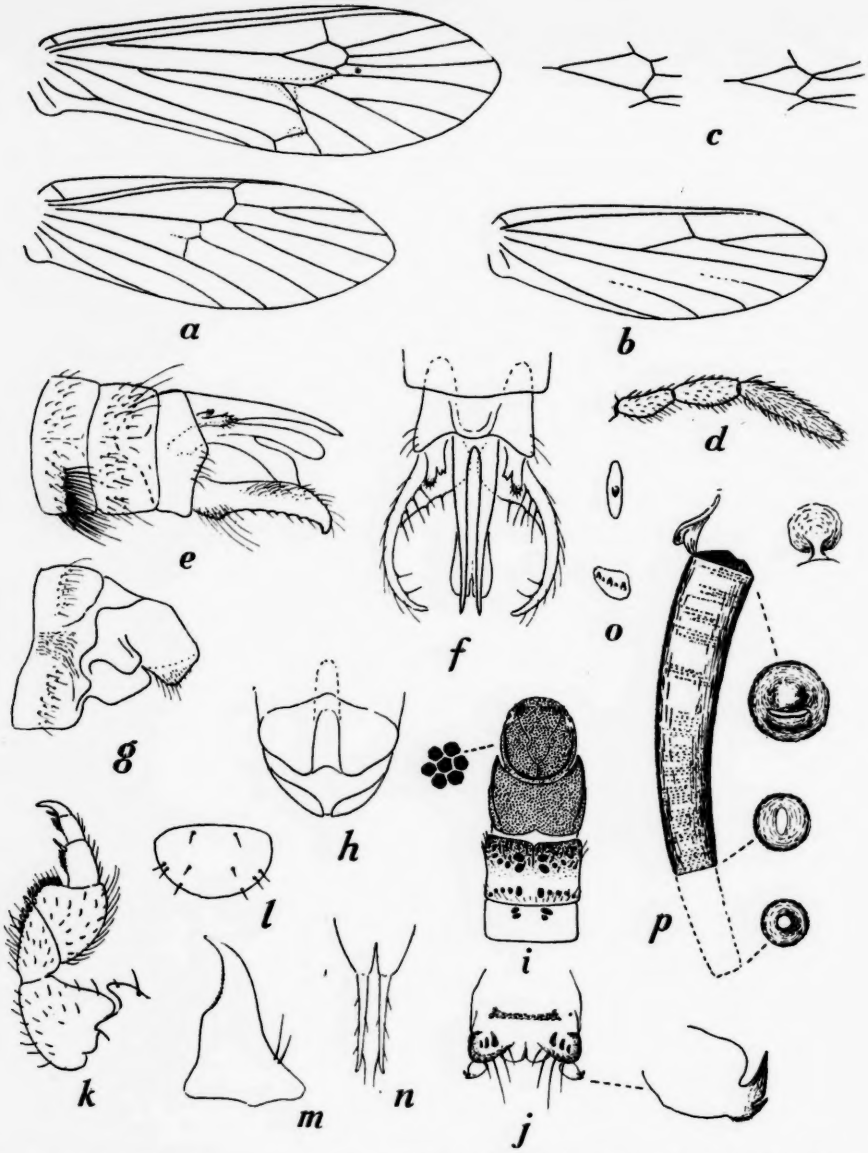

FIG. 15.—*Barbarochthon brunneum* n. g., n. sp. *a*, fore- and hind-wings ♀, dotted lines indicating hyaline areas on membrane; *b*, hind-wing ♂; *c*, variations in discoidal cell and origin of forks 1 and 2; *d*, maxillary palp ♂; *e*, *f*, lateral and dorsal views of ♂ genitalia; *g*, *h*, lateral and ventral views of ♀ genitalia; *i*, head and thorax of larva, with honeycomb arrangement of pigment; *j*, terminal segments of abdomen, with anal claw further enlarged; *k*, fore leg of larva, with plaque d'appui; *l*, labrum of pupa; *m*, mandible of pupa; *n*, anal appendages of pupa; *o*, dorsal plates of 5th segment of pupa; *p*, pupal case, with surface view of adhesive disc, membranes from front and hind ends, dotted line indicates length of larval case, with membrane from hind end.

Mid tarsi fringed. Lateral line beginning at middle of segment 6. No gills. Presegmental dorsal plates on segments 2–6, postsegmental also on segment 5. Anal appendages rod-like, slender.

Case the same as that of larva, affixed to rocks by attachment disc arising from dorsal side of tube. Hind end closed by membrane with rather large circular aperture; at about one-third the length from the hind end is a thin septum with vertical narrow straight slit. Front end closed by membrane with narrow transverse crescentic slit.

Hydrosalpinx sericea n. sp.

(Fig. 16.)

Imago.—Head and thorax fulvous with pale golden hairs. Legs and antennae ochraceous or fulvous, the latter darker proximally. Wings thickly pubescent; fore-wing bright golden-brown, the costal area and the apical cells duller and darker brown, the veins paler and brighter; hind-wing greyish-brown, fringe grey. Fore-wing ♂ 9–10 mm., ♀ 11–12 mm. Maxillary palp ♂ 5 mm., ♀ 3 mm. Labial palp ♂ 4 mm., ♀ 1·5 mm.

Genitalia ♂, 9th and 10th tergites fused, apically with short cleft, the lobes somewhat divergent; preanal appendages elongate, straight, with knob-like process at base on lower side; clasper with lower branch broadly lobate, thickly setose, upper branch slender, geniculate, apically acute. ♀ see under genus and fig. 16 *h*.

Larva.—Head and pronotum fulvous-castaneous, with paler marks. Mesonotum paler brown. Legs and anal holdfasts dark amber. Abdomen creamy-white. Up to 15 mm.

Case up to 24 mm. in length, mouth 2 mm. or slightly wider, hind end ·75–1 mm.

Pupa.—9–10 mm. Presegmental and postsegmental dorsal plates each with 2–3 spines.

Localities.—Hottentots Holland Mts. (K. H. B., March 1919, 1 ♂, 1 ♀); Wolvenhoek Kloof, French Hoek (K. H. B., April 1931, 1 ♂); Jonkershoek, Stellenbosch (H. G. W., February and April 1931, ♂ and ♀ pupae); Bosch Kloof, Keeromberg, Worcester (K. H. B., January 1930, larvae); River Zonder End Mts. (H. G. W., December 1931, larva); Cedar Mts., Clanwilliam (K. H. B., January 1930, larvae); Du Toit's Kloof, Rawsonville (K. H. B., March 1932, cases); Gt. Winterhoek Mts., Tulbagh (K. H. B. and H. G. W., November 1932, larvae); Bain's Kloof, Wellington Mts. (K. H. B., 14th April 1933, ♂♂; K. H. B. and H. G. W., 1st May 1933, ♂♂, ♀♀).

Remarks.—In fore-wing R_2 is usually straight, not (as shown in the figure) kinked at the cross-vein connecting R_1 with discoidal cell, and the latter 4-sided (not 5-sided as in figure). In the ♀ M_{3+4} and Cu_{1a} are evenly spaced between M_2 and Cu_{1b}, but in the figure Cu_{1a} is dotted in to show its point of origin.

The species is common, and in the resting position and flight strongly resembles a Sericostomatid (cf. *Rhoizema*).

Petrothrincus n. g.

Imago.—Tibial spurs 2, 2, 4. Ocelli absent. Antennae slightly longer than fore-wing, basal joint as long as head, 2nd ½ length of 1st, 3rd twice the 2nd. Maxillary palp 5-jointed ♂ ♀, rather long, and densely covered with thickened hairs, 1st and 2nd joints subequal, not very short, 3rd, 4th, and 5th in ♀ subequal to one another, slightly longer than 1st or 2nd, in ♂ 4th and 5th as in ♀, but 3rd slightly longer. Labial palp about half length of maxillary palp, the joints subequal to one another, and to 1st or 2nd joint of maxillary palp. In fore-wing apical forks 1, 2, 3, fork 2 sessile, 3 shortly stalked; Cu_1 simple, fork 5 therefore absent. In hind-wing costal area very broad proximally, Sc and R curving up to costal margin; discoidal cell absent; only apical fork 2 present; M simple in ♂, forked in ♀; Cu_1 apparently fused with M in ♂, and Cu_2 rudimentary. Genitalia ♂, 9th (apparently) tergite more or less produced, preanal appendages prominent, a pair of titillators (or upper penis sheath), penis simple, clasper stout, spoon-shaped, with internal basal branch and a small uncinate titillator, 9th sternite produced, entire or bifid; ♀ terminal tergite with slight apical projection, sternite (in lateral view) oblique, with fine corrugations.

Larva.—Suberuciform, somewhat flattened, widening to metathorax, thence decreasing in width. Head not retractile. Mandibles stout, not toothed, with internal tuft. Pronotum horny. No prosternal spine. Meso- and metanotum membranous, the former with 3–4 pairs of small chitinous plates medianly. Fore leg stout and short. Plaque d'appui curved, apically truncate. Hind leg longest. Claws short, basal seta not on a process. Abdominal segments feebly constricted. Segment 1 with large transversely oval dorsal hump. Lateral line absent. Gills small, simple or branched, presegmental dorso-laterally, laterally, and ventrally on segment 2, ventrally on segments 3–6. Anal holdfasts with numerous accessory denticles on the claw.

Case composed of fine sand-grains, scutiform, in side view plano-convex, with more or less widely expanded lateral and frontal margins, entirely concealing the conical tube in which the larva lives, tube opening posteriorly by a small dorsal aperture. Closely applied to rocks and stones in mountain streams.

Pupa.—Cylindrical. Antennae a little longer than body. Labrum semi-circular. Mandible strong, triangular, inner margin feebly serrate. Fore and mid tarsi fringed. Lateral line and gills absent. Dorso-lateral hind corners of abdominal segment 1 minutely scabrous. Dorsal chitinous plates on segments 3–6 presegmental, and postsegmental on segment 5. Anal appendages long, slender.

Case the same as that of the larva. Larval exuviae expelled through hind aperture. Emergence through a circular hole antero-dorsally.

Genotype: *P. circularis* n. sp.

Remarks.—The genus bears a general resemblance to *Thremma* in the venation of the female, and the scutiform larval case. There are several peculiarities, however, in the venation, including the dissimilarity in the sexes. The larval resemblances are evidently due to similarity of habitat, and do not necessarily indicate relationship.

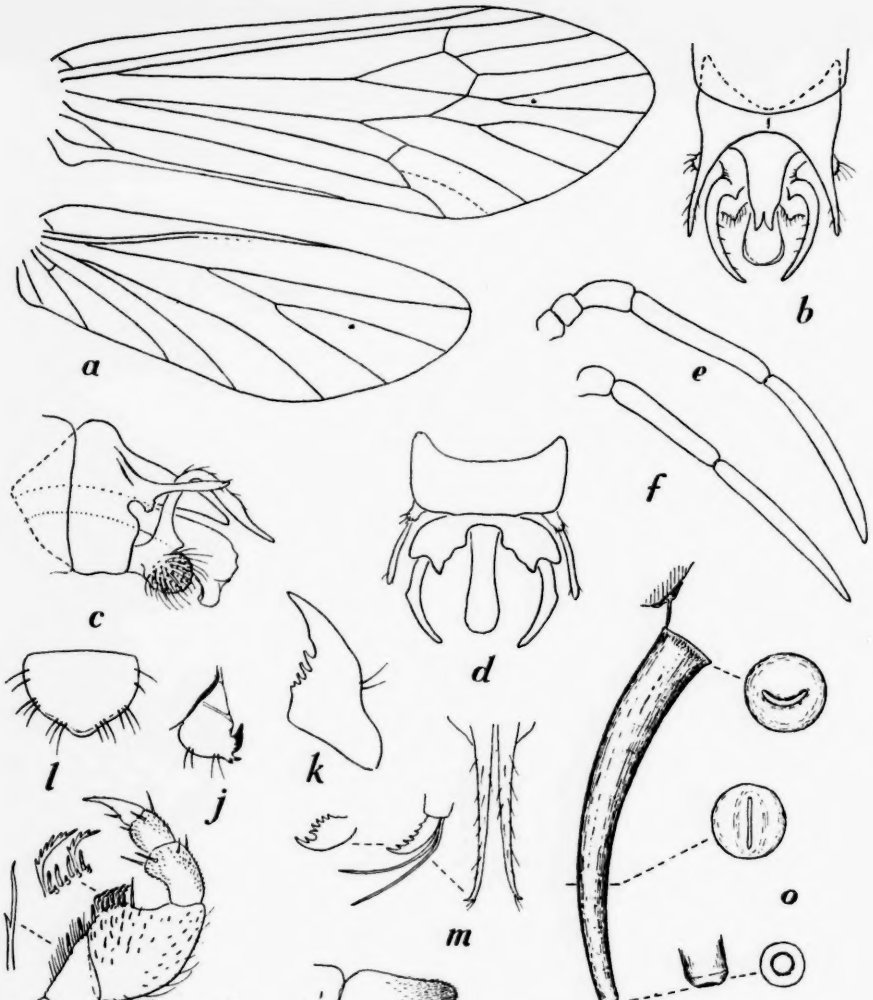

FIG. 16.—*Hydrosalpinx sericea* n. g., n. sp. *a*, fore- and hind-wings ♂, dotted line indicates course of Cu_{1a} in ♀; *b*, *c*, *d*, dorsal, lateral, and ventral views ♂ genitalia; *e*, *f*, maxillary and labial palps ♂; *g*, hind-wing ♀; *h*, lateral view ♀ genitalia, with dorsal view of apex; *i*, fore leg of larva; *j*, anal holdfast of larva; *k*, *l*, mandible and labrum of pupa; *m*, anal appendages of pupa, with apex further enlarged, and variation; *n*, dorsal plates of 5th segment of pupa; *o*, pupal case, with front and hind opercula and internal septum further enlarged.

Although by rights *triangularis* Hagen should be made the genotype, I have no adults from the type locality (Swellendam), and the true *triangularis* may possibly, though not probably, prove to be different from the Gt. Winterhoek specimens which I am describing as Hagen's species. In that case the Gt. Winterhoek specimens would require a new name. I therefore make *circularis* the genotype.

Petrothrincus circularis n. sp.

(Figs. 17, 18 *a–f, r.*)

Imago.—Head and thorax fuscous with silvery-white hairs. Legs and palps grey. Antennae dark brown. Wings grey-brown, fore-wing with silvery-white hairs in patches, the chief ones being: middle of costal area, pterostigmal area, area between apical forks 1 and 2, on either side of cross-vein closing discoidal cell, thyridial cell, and along Cu_2; hind-wing with large patch of blackish hairs in middle of lower surface in female. Abdomen orange-fulvous, the tergites and sternites darker brown.

Fore-wing ♂ 6–6·5 mm., ♀ 6·5–7·5 mm. Antennae 8 mm.

Genitalia ♂, 9th tergite triangular, preanal appendages straight, titillators (upper penis sheath) slender, slightly curving upwards, clasper ovoid, lower margin apically excised (in lateral view), with sharp down-curved apex, inner branch notched on lower margin, uncinate titillator small, penis apically narrowly rounded, 9th sternite apically truncate. ♀ dorsal process of apical tergite very shortly projecting, apically truncate.

Larva.—Gills on segment 2: 1–2 dorso-lateral, simple or bifid, lateral and ventral, 3–4 branched; on segments 3 and 4: 3–4 branched ventral; on segment 5: 2–3 branched ventral; on segment 6: 1 simple ventral. Up to 7 mm.

Head and pronotum pale horn-colour with pale amber markings. Legs pale amber. Rest of body creamy or yellowish. Eyes black.

Case circular or subcircular, up to 9 mm. in length, 7–8 mm. in width.

Pupa.—Presegmental dorsal plates each with one crotchet, postsegmental plates on segment 5 each with two crotchets. 6–8 mm.

Localities.—Table Mt., Cape Town (K. H. B., February–April, ♂♂, ♀♀). Type locality. Groot Drakenstein (A. C. H.); Jonkershoek, Stellenbosch (K. H. B. and H. G. W.); Witte River, Wellington Mts. (K. H. B., November 1922); River Zonder End Mts. (H. G. W.); Palmiet River (H. G. W.); Hottentots Holland Mts. (K. H. B.); Gt. Winterhoek Mts. (K. H. B. and H. G. W.); French Hoek Mts. (K. H. B. and H. G. W.); Elands Kloof, Citrusdal (H. G. W.).

Remarks.—This is a common species in mountain streams. The flies appear on Table Mt. in February–April, but the larvae may be found throughout the year. Up to the present imagos have only been obtained from Echo Valley on Table Mt., which is thus the type locality. The other localities are based on larvae and pupae only. It is possible that imagos from these other localities may prove to be different species or varieties. Thus a single ♀ from Groot Drakenstein has a slightly different terminal dorsal process (fig. 18 *f*). In the larvae the gills show slight variations; the dorsal gills on segment 2 may be absent, and some or all of the others simple, not branched; those on segment 6 may be absent.

Although the act of oviposition has not been observed, several ♀♀ have been captured with an egg-mass still attached to the end of the abdomen, and covered with the long black hairs which are developed on the underside of the hind-wings.

Petrothrincus triangularis (Hagen).

(Fig. 18 *g–q.*)

Hagen, 1864, p. 225 (*Molanna triangularis*, case only).

Imago.—Colour and venation as in *circularis*.

Fore-wing ♂ 5·5–6 mm., ♀ 6–6·5 mm. (bred specimens may be rather below normal size). Genitalia ♂, 9th tergite ovate, preanal appendages curved, titillators shorter and stouter than in *circularis*, clasper in lateral view more oblong, inner branch without excision on lower margin, uncinate titillator larger (not always pointing upwards as figured), penis more or less apically bifid, with two small chitinised ventral processes, 9th sternite widely bifurcate. ♀ dorsal process stronger, ovate.

Larva and pupa as in *circularis*.

Case similar to that of *circularis*, but triangular in shape, the sides nearly straight, the lateral margins much narrower, and differences in cross-section as shown in fig. 18 *q*. Length 8 mm., width in front 4 mm.

Localities.—Swellendam (Hagen, case only); Great Winterhoek Mts., Tulbagh (K. H. B. and H. G. W., November 1932, larvae, ♂♂ ♀♀ bred out March 1933); Jonkershoek, Stellenbosch (H. G. W.); Witte River, Wellington Mts. (K. H. B., 1922); Bain's Kloof, Wellington Mts. (K. H. B. and H. G. W., 1st May 1933, ♀♀); Hottentots Holland Mts. (K. H. B. and H. G. W., 1932); Du Toit's Kloof, Rawsonville (K. H. B., 1932); Mostert's Hoek and Waai Hoek Mts. (K. H. B., April 1933); Bosch Kloof, Keeromberg, Worcester (K. H. B., 1930); Cedar Mts., Clanwilliam (K. H. B., 1930); French Hoek Mts. (K. H. B. and H. G. W., 1932).

Remarks.—Hagen's description of the case makes this form unmistakable. It is, however, possible that more than one species makes a similar case. Up to the present I have obtained imagos only by breeding from the larvae collected in the Gt. Winterhoek Mts., and this locality must be regarded as the type locality. If imagos from Swellendam prove to be different, the specimens here described should be renamed.

Slight variations have been noticed in the shapes of the 9th sternite and the titillators (fig. 18 *k, l*).

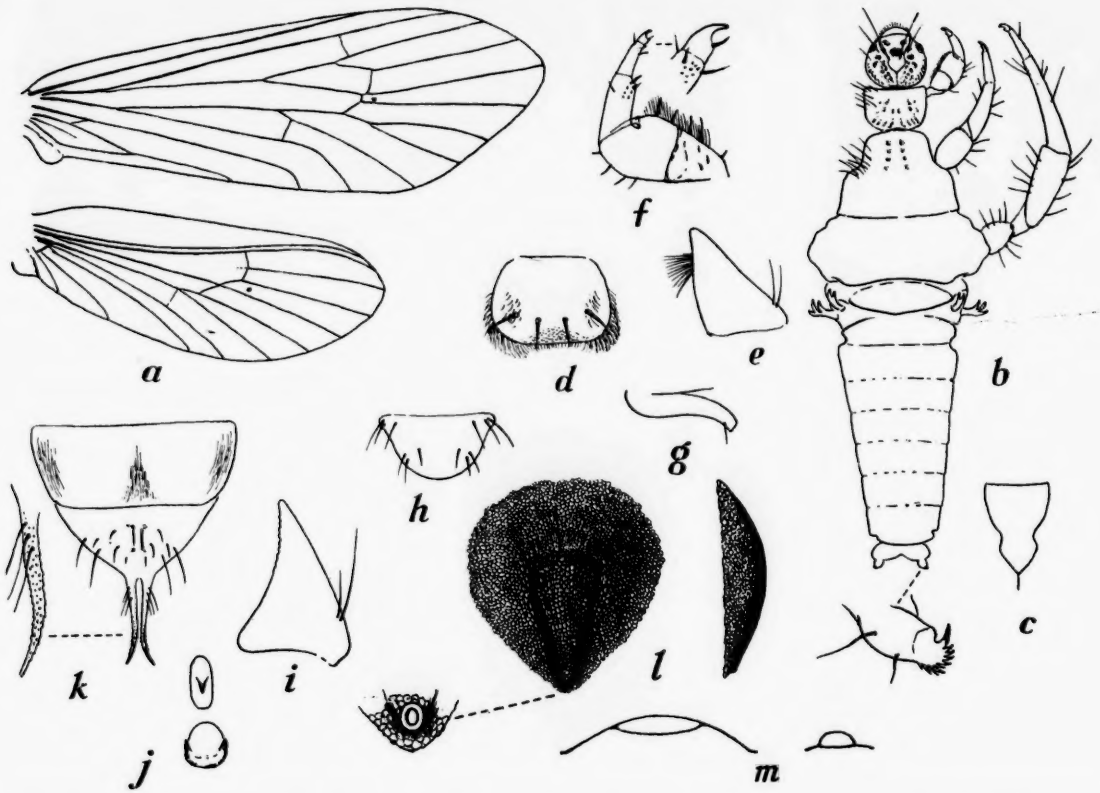

FIG. 17.—*Petrothrincus circularis* n. g., n sp. *a*, fore- and hind-wings ♀; *b*, larva, with anal holdfast further enlarged; *c*, clypeus; *d*, *e*, labrum and mandible of larva; *f*, fore leg of larva, with claw further enlarged; *g*, plaque d'appui; *h*, *i*, labrum and mandible of pupa; *j*, dorsal plates of 5th segment of pupa; *k*, anal appendages of pupa, one of them further enlarged; *l*, upper and lateral views of case, with aperture at hind end further enlarged; *m*, diagrammatic cross-sections of case at front and hind ends of tube.

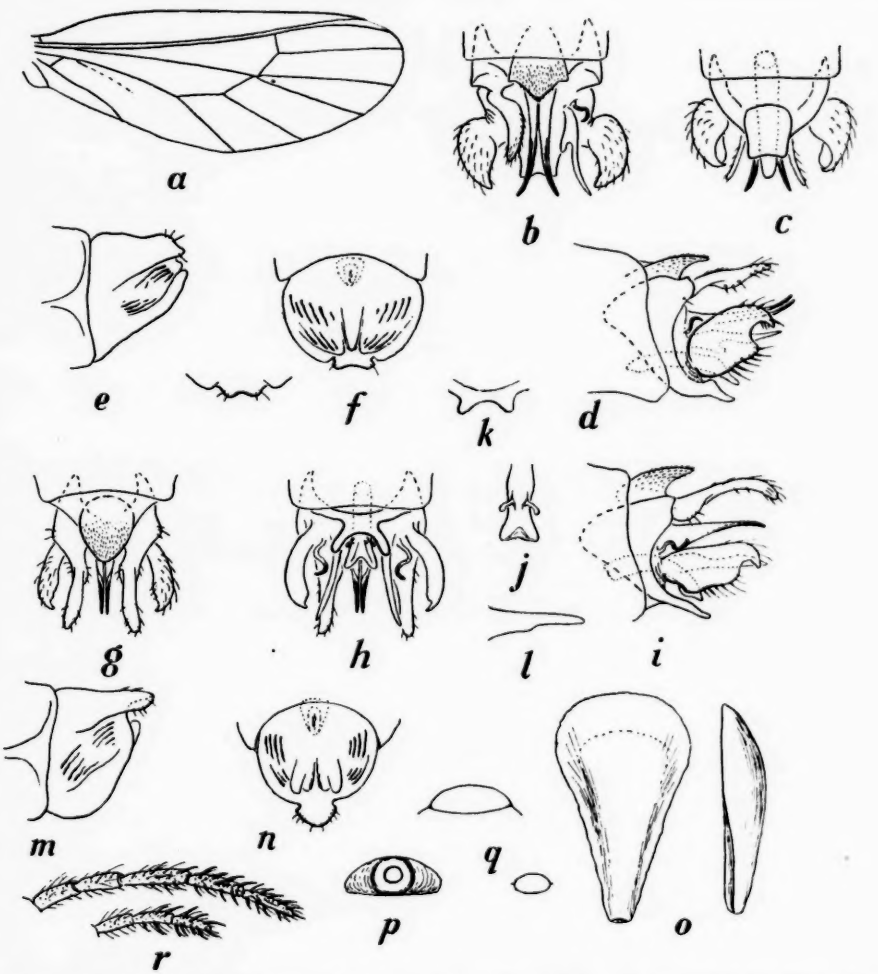

FIG. 18.—*Petrothrincus circularis* n. g., n. sp. *a*, hind-wing ♂; *b*, *c*, *d*, dorsal, ventral, and lateral views genitalia ♂; *e*, *f*, lateral and ventral views genitalia ♀ from Table Mt., with apical projection of a specimen from Groot Drakenstein; *r*, maxillary and labial palps. *Petrothrincus triangularis* (Hagen). *g*, *h*, *i*, dorsal, ventral, and lateral views genitalia ♂; *j*, ventral view of penis; *k*, *l*, variations in shape of 9th sternite and titillator; *m*, *n*, lateral and ventral views genitalia ♀; *o*, dorsal and lateral outlines of case; *p*, posterior view of hind end of case with aperture; *q*, diagrammatic cross-sections of case at front and hind ends of tube.

Family Calamoceratidae.

Ulmer, 1907, p. 113.

Imago.—Tibial spurs usually 2, 4, 4, seldom 2, 4, 3 or 2, 4, 2. Hind leg sometimes elongate. Antennae usually longer than fore-wing. Ocelli absent. Maxillary palp strong, last joint not segmented, or with at most two segments. In fore-wing discoidal and median cells closed; thyridial elongate; apical forks (♂, ♀) 1, 2, 3, 4, 5. In hind-wing discoidal cell closed or open, median cell open; apical forks usually 1, 2, 3, 5; stalk of fork 5 with long hairs. R ends in R_2 in fore-wing usually, in hind-wing always. Genitalia ♂, preanal appendages large, penis without titillators, claspers 1-jointed.

Larva.—Very little is known about the life-history in this family. F. Müller described the larva of *Phylloicus* (Arch. Mus. Nac. Rio de Janeiro, vol. iii, pp. 113, 131, pl. ix, 1880), and Ulmer described a larva which he assigned to the genus *Anisocentropus* (1909, p. 359). The latter is eruciform, the body and especially the abdomen dorso-ventrally depressed, the antero-lateral angles of the prothorax acutely produced forwards, hind tibia divided into two parts, claws short. Case depressed, lenticular in cross-section, composed of pieces of leaf.

Remarks.—Two genera are known from Africa: *Anisocentropus*, which occurs also in North America, India and East Indies, and Australia; and *Ganonema*, which occurs also in North and South America, and the Indian region. One of the recorded localities (Zomba) for one of the *Anisocentropus* species lies just south of 15° S. lat., and consequently the family can be included in the South African fauna list.

Gen. *Anisocentropus* McLach.

Ulmer, 1907, p. 118, and 1929, p. 167; Lestage, 1919A, pp. 310, 331.

Imago.—Tibial spurs 2, 4, 3. Maxillary palp 6-jointed (*i.e.* the 5th joint divided into two). R in fore-wing continued to margin, in hind-wing uniting with R_2 distally.

The following key to the two African species is adapted from Ulmer (1929):

1. Wings yellowish. In fore-wing cross-vein between Cu_1 and Cu_2 proximal to apical fork 5.
voeltzkowi Ulmer (Madagascar).

2. Wings dark brown. In fore-wing cross-vein lies between Cu_1 and Cu_2, *i.e.* distal to the fork of 5.
usambarensis Ulmer (Usambara, Nairobi, Spanish Guinea, Zomba in Nyassaland).

Gen. *Ganonema* McLach.

Ulmer, 1907, p. 115; Navas, 1931, p. 277.

Imago.—Tibial spurs 2, 4, 4, rarely 2, 4, 3, those of the fore tibia minute. R in both wings joining R_2 distally.

G. annulicorne Navas, 1931, p. 277, fig. 63 (on p. 278 fig. misplaced). Belgian Congo.

Family Leptoceridae.

Ulmer, 1907, p. 129; Lestage, 1921, p. 597 (larvae, pupae); Mosely, 1932, p. 297 (new genera), and 1932A, p. 128; Lestage, 1919, p. 202 (n. g.).

Imago.—Tibial spurs usually 2, 2, 2, less often 1, 2, 2 or 0, 2, 2. Antennae very slender, 2–3 times length of fore-wing, 1st joint stout. Ocelli absent. Maxillary palp slender, 5th joint flexible but not segmented. Fore-wing usually narrow, no median cell, discoidal cell always closed, thyridial cell long (rarely absent), apical forks 1, 5 in ♂ ♀, or sometimes 1, 3, 5 in ♀, a spurious 2 also sometimes present. In hind-wing usually apical forks 1, 5. Genitalia ♂, variable.

Egg-mass.—Gelatinous, spherical or disc-shaped (Ulmer, 1909A, pp. 203, 206), dropped while ♀ hovers over water.

Larva.—Eruciform. Antennae usually long. Mesonotum with two chitinous plates, metanotum membranous. Legs often densely fringed, unequal, but middle leg never longer than hind leg. Mid and hind femora of two pieces. Apical spines of fore and mid tibiae not situated on projections. No prosternal spine. Maxillary palp 4-jointed. Labial palp 2-jointed. Lateral line very fine or absent. Gills present or absent, simple or in tufts. Anal holdfasts short.

Case usually narrow, conical, composed of sand-grains, vegetable matter, or simply silk.

Pupa.—Antennae much longer than body, apically coiled round end of abdomen. Mandibles slender. First abdominal segment with lateral spinulose or tuberculose plates. Anal appendages rod-like.

Remarks.—Like the *Sericostomatidae*, this family is regarded as not being entirely natural, hence no very detailed diagnosis of any of the stages can be given. It is well represented in South Africa; in fact, large additions to the fauna list may be expected as the result of future collecting.

All the genera belong to the subfamily *Leptocerinae*, in which the discoidal cell in hind-wing is open or absent.

Key to the African genera of Leptocerinae.

I. Fore-wing scaly. Tibial spurs 1, 2, 2. Fore-wing with apical forks 1, 5 ♂, 1, 3, 5 ♀. Hind-wing with area between costal margin and Rs very wide, no discoidal cell . . . *Pseudoleptocerus.*

II. Fore-wing not scaly. Hind-wing with area between costal margin and Rs normal, discoidal cell open.

A. Fore-wing with thyridial cell absent, and anastomosis straight. Apical fork 5 absent in hind-wing (Cu_1 simple).

1. No scent gland on antenna ♂. 1st and 2nd joints of maxillary palp equal . *Triaenodes.*
2. A scent gland on antenna ♂. 1st joint of maxillary palp shorter than 2nd. *Triaenodella* (East Africa).

B. Fore-wing with thyridial cell present.

1. Cu_1 in hind-wing forked. Anastomosis in fore-wing more or less obliquely graded.

a. Apical fork 1 in hind-wing present.

i. M in hind-wing simple . . . . . *Parasetodes.*

ii. M in hind-wing forked.

a. Tibial spurs 2, 2, 2. Hind-wing usually broad at base. Fore-wing with forks 1, 5 ♂, 1, 3, 5 ♀.

* 4th apical cell ♂ (4th and 5th ♀) stalked . . *Leptocerus* spp.

** 4th apical cell sessile reaching anastomosis. *Leptocerina* (Nyassaland and Tropical Africa).

β. Tibial spurs 0, 2, 2. Fore-wing with forks 1, 5 in both sexes. Hind-wing not so broad at base (except *Homilia*).

* M in fore-wing simple.

† Sc and R separate to margin . . . . *Oecetis.*

†† Sc and R united by thick oblique cross-vein . *Potamoryza.*

** M in fore-wing forked.

† Rs present in hind-wing.

§ Wings broad, especially hind-wing . . *Homilia.*

§§ Wings narrow . . . . . *Setodes.*

†† Rs absent or rudimentary in hind-wing.

§ Basal joint of antenna with brush of setae. *Trichosetodes* (Ceylon and Sudan).

§§ Antenna without brush . . *Hemileptocerus* (Sudan).

b. Apical fork 1 in hind-wing absent.

i. M in hind-wing forked.

a. Tibial spurs 2, 2, 2.

* Fore-wing with forks 1, 5 ♂, 1, 3, 5 ♀ . . *Leptocerus* spp.

** Fore-wing with forks 1, 5 in both sexes . . *Leptecho.*

β. Tibial spurs (presumably) 1, 2, 2 *Setodellina* (Belgian Congo and Sudan).

ii. M in hind-wing simple . . . . *Ptochoeectis* (Sierra Leone).

2. Cu_1 in hind-wing simple. Anastomosis in fore-wing straight . . . . *Adicella.*

Haplosetina Navas, 1931, p. 143, from the Belgian Congo, seems to be synonymous with *Ptochoeectis.*

Gen. *Pseudoleptocerus* Ulmer.

Ulmer, 1907, p. 136; Lestage, 1919A, p. 312; Navas, 1930A, p. 334.

Imago.—Tibial spurs 2, 2, 2. Fore-wing with discoidal cell usually not as long as its stalk, upper margin convex; thyridial cell narrower than discoidal; apical forks 1, 5 ♂, 1, 3, 5 ♀. In hind-wing area between Sc and R very broad; discoidal cell absent; apical forks 1, 5; M forked. Fore-wing densely covered with scales as well as hairs.

Larval and pupal stages unknown.

Remarks.—*P. squamosus* Ulmer is known from Cameroon and Belgian Congo; and *schoutedeni* Navas also from the Belgian Congo.

Pseudoleptocerus cupreus n. sp.

(Fig. 19 *a–h.*)

Imago.—In fore-wing discoidal and thyridial cells subequal, and subequal to stalk of former. In hind-wing apical fork 5 lenticular. Genitalia ♂, 10th tergite bilobed, each lobe with a spine pointing downwards, preanal appendages absent, penis in a sheath, the lower half of which is spoon-shaped, the upper half ∩-shaped in cross-section, the median portion curved upwards, claspers slender, 2-jointed, 9th sternite with a short triangular process.

Fore-wing ♂ 7–7·5 mm., ♀ 5·5 mm. Antennae 15–16 mm.

Head and thorax dark fuscous brown, with white or greyish-white hairs. Maxillary palps brown with white, grey, and black hairs and setiform scales, sometimes the white predominates, sometimes the black (irrespective of sex). Antennae brown, narrowly annulate with white. Legs brown, the hind tarsi often pale or their joints annulate. Wing membrane of fore-wing pale brown, darker at base and in pterostigmal area. Scaling brown-umber on costal margin before and after the large triangular pale patch, and on distal portion, but leaving a rather wide margin; the apparently naked patches in reality covered with metallic white, sea-green, or peacock-blue scales, varying according to the angle of incidence of light, the margin more of a

lilac or pale violet tinge; the remaining areas with deep golden or coppery scales shading off into the brown-umber. Base of wing with long, scattered, dark brown hairs. Hind-wing iridescent, marginal fringes pale sepia.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, ♂♂, ♀♀).

Remarks.—This is the most brightly-coloured Caddis-fly yet known in the South African fauna. In a living or fresh specimen the contrast between the metallic blue and coppery patches is very striking; but the scales are mostly very deciduous, and cabinet specimens give but a poor idea of the true brilliance of the fly.

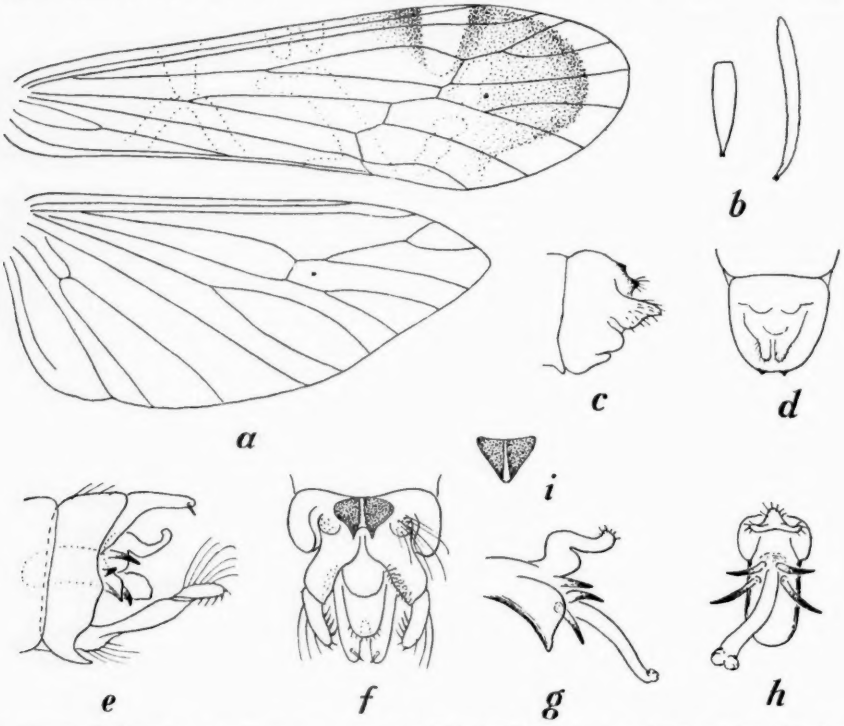

FIG. 19.—*Pseudoleptocerus cupreus* n. sp. *a*, fore- and hind-wings of ♂; *b*, scales from wing (short) and maxillary palp (long); *c*, *d*, lateral and ventral views genitalia ♀; *e*, *f*, lateral and ventral views genitalia ♂; *g*, *h*, lateral and posterior views of penis and sheath; *i*, projection of 9th sternite of var. *subfuscus* n.

Var. *subfuscus* n.

(Fig. 19 *i*.)

Imago.—Similar to the typical specimens, but with more extensive dark scaling, in particular a dark cross-bar from about base of the discoidal cell across the middle of the thyridial cell; and the typical deep golden scaling is here pale golden. A slight difference in the projection of the 9th sternite in ♂ genitalia is shown in the figure.

Locality.—Clanwilliam, Cape Province (S.A. Mus., 1898, 1 ♂).

Remarks.—If the locality is correctly recorded, this is a very noticeable extension of the distribution of this apparently tropical and subtropical genus. Historically this specimen is interesting as being the first imago Caddis to be collected in the Cape.

Gen. *Triaenodes* McLach.

Ulmer, 1907, p. 140; 1912, p. 110. Lestage, 1919A, p. 316; 1921, p. 623 (larva and pupa). Banks, 1920, p. 352.

Imago.—Tibial spurs 1, 2, 2. No scent gland on antenna ♂. Maxillary palp, 1st and 2nd joints equal,

3rd much longer, 4th and 5th subequal or 5th slightly longer. Wings narrow. In fore-wing discoidal cell large, not joined to R by a cross-vein; thyridial cell absent; apical forks 1, 2, 5 ♂ ♀; anastomosis nearly straight and transverse. Hind-wing not much broader than fore-wing, apical forks 1, 2 only, Cu_1 being simple. Genitalia ♂, preanal appendages rod-like, directed upwards, 10th tergite deeply cleft, claspers 2-jointed.

Larva.—Head oval. Antennae long, distal joint with long apical seta. Mandibles chisel-like, asymmetrical. Hind legs very long, fringed, Hind tibiae of two pieces. Lateral line absent. Gills simple. A chitinous plate on 9th tergite of abdomen.

Case conical, straight, composed of small pieces of vegetable matter arranged spirally.

Pupa.—Labrum with 5–6 lateral setae, and a short blunt median projection on distal margin. Presegmental dorsal plates on segments 3–6 only. Gills present.

Case the same as that of the larva.

Remarks.—The genus is found in Europe, North America, and Africa. Five species are known from the latter region, only one of which extends into South Africa.

Triaenodes elegantula Ulmer.

(Fig. 20 *a–e.*)

Ulmer, 1908, p. 6, pl. i, figs. 18, 19, and 1913, p. 191; Lestage, 1919A, p. 317.

Imago.—In fore-wing space behind discoidal cell slightly broader than latter, which is twice as long as its stalk; lower branch of fork 1 subequal to its stalk. In hind-wing stalk of fork 1 half as long again as lower branch of fork; fork 2 sessile. Genitalia ♂, 10th tergite twice as long as broad, deeply and widely bifurcate, upper lobe of penis bifid, lower lobe with lateral expansions, basal joint of clasper short, with very elongate slender curved process, 2nd joint with spines at apex and a small slender process near base, curving outwards and bearing two long setae. ♀ with prominent medio-ventral knob-like process.

Fore-wing 8·5–9 mm.

Head and thorax fulvous-ochraceous, with pale yellowish or whitish hairs. Wings ochraceous with pale golden hairs, neuration pale. Antennae obscurely and narrowly annulate.

Locality.—M'fongosi, Zululand (W. E. Jones, March, September, October, November 1911, 1912).

Distribution.—Usambara and Tanganyika.

Remarks.—Ulmer has seen South African specimens, and in deference to him I retain these specimens under the name of the East African species. There are small differences, however, which might justify at least a varietal name. The 10th tergite is not at all narrow, as stated in Ulmer's 1908 description; as represented in his fig. 18, it corresponds more with the upper lobe of the penis in the present specimens. The small process on the 2nd joint of the clasper is neither mentioned nor figured by Ulmer. The South African specimens also are larger.

Gen. *Parasetodes* McLach.

Ulmer, 1907, p. 137, and 1922, p. 57.

Imago.—Tibial spurs 1, 2, 2. Fore-wing narrow, hind-wing broad. Apical forks 1, 5 in both wings. In fore-wing thyridial cell long. In hind-wing M simple, Cu_1 forked.

Remarks.—One species (*respersella* Rambur) is known from France and Egypt (Ulmer, 1931, p. 3), and another (*sudanensis* Ulmer, 1922) from the Sudan and Mozambique.

Parasetodes sudanensis Ulm.

Ulmer, 1922, p. 57, figs. 17, 17 *a*; Mosely, 1932D, p. 4.

Locality.—Chemba, Zambesi, Portuguese East Africa (Mosely).

Distribution.—Sudan (Ulmer).

Parasetodes sp.

(Fig. 20 *f.*)

Imago.—In fore-wing discoidal cell broad distally, its length a little longer than its stalk; thyridial cell longer than discoidal. Courses of Cu_2 and the anal veins in fore-wing not quite the same as in *respersella*. Maxillary palp strongly hairy, with thickened hairs, 2nd joint longest, 3rd longer than 4th, which is subequal to 5th.

Fore-wing 8 mm.

Head and thorax fulvous with whitish hairs. Maxillary palp annulate. Legs very pale ochraceous, almost white. Wing membrane transparent, neuration pale, with brown spots (see fig. 20 *f*); hairs pale buff, those on the dark spots brown; nearly all the longitudinal veins have small dark dots along them, and at their junctions with the cross-veins; the most conspicuous spots are at the forks of Rs, fork of M and Cu, between discoidal cell and end of Sc, and a streak along upper vein of apical cell 4. Bases of hind-wings mutilated. Antennae, fore-legs, and abdomen missing.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B., March 1923, 1 specimen).

Remarks.—Ulmer has not figured the wing of the Sudan species, but there seems to be considerable similarity between his species and the Kunene specimen. Without knowing the genitalia of the latter, it would be unwise to pronounce them either distinct or the same. No specific name is therefore attached.

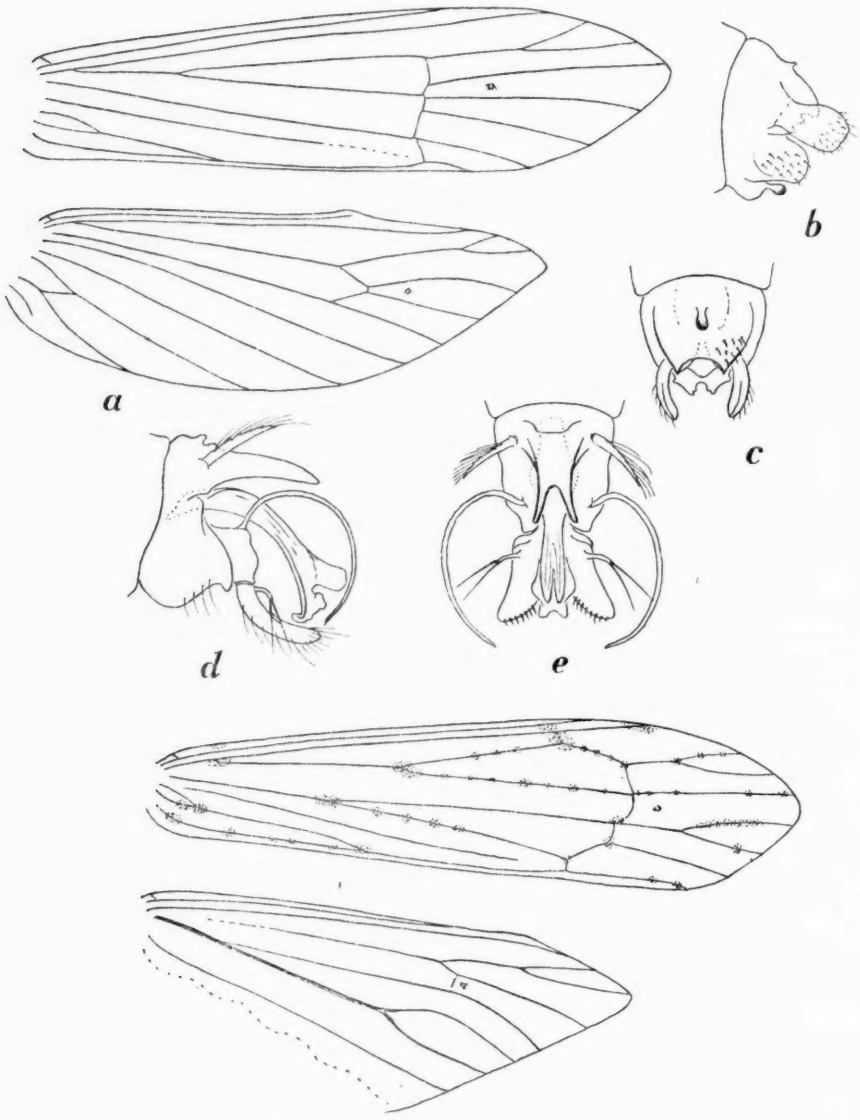

FIG. 20.—*Triaenodes elegantula* Ulmer. *a*, fore- and hind-wings; *b*, *c*, lateral and ventral views genitalia ♀; *d*, *e*, lateral and dorsal views genitalia ♂. *Parasetodes* sp. *f*, fore-wing and mutilated hind-wing.

Gen. *Leptocerus* Leach.

Ulmer, 1907, p. 134; 1912, p. 102; 1922, p. 53; 1931, p. 20. Navas, 1930, p. 332. Lestage, 1919A, p. 313; 1921, p. 605 (larva and pupa).

Imago.—Tibial spurs 2, 2, 2, those of fore tibia short. Antenna usually more than twice length of fore-wing, shorter in ♀ than in ♂. Maxillary palp strongly hairy, 2nd joint longest. Fore-wing narrow, discoidal and thyridial cells long. Apical forks 1 and 5 ♂, 1, 3, 5 ♀. Apical cells 1 and 4 (in ♂; in ♀ 4th and 5th) stalked. Hind-wing broader than fore-wing, discoidal cell open. Apical forks 1 and 5 in both sexes. M forked, cross-vein from R_{4+5} joining M before latter forks. Genitalia ♂, 9th tergite usually triangularly produced, 10th tergite often deeply cleft, usually flat, sometimes with a pair of appendages; preanal appendages usually short, stout; claspers pointing upwards, often biramous, the lateral branch sometimes 2-jointed.

Larva.—Head rather small, oval. Antennae shorter than in some other genera. Mandibles chisel-like, the left with internal tuft of setae. Trochanters of all legs of two pieces*; mid and hind femora of two pieces; hind tibia of one piece. Lateral line very fine. Gills typically in tufts, but absent in all South African species as yet discovered.

Case conical, straight, or gently curved, composed entirely of silk, or of sand-grains or vegetable particles.

Pupa.—Labrum with 4–6 lateral setae, and a more or less prominent median projection. Presegmental dorsal plates on segments 3–6 or 7. Gills typically in tufts, but in South African forms absent.

Case the same as that of larva, or sometimes rebuilt, either of similar or different materials.

Remarks.—The genus occurs throughout the world, except in Australasia. It will probably be split up into sections or even independent genera (cf. *Leptocerina*).

The species here described fall into two easily separable groups: *fissus* and *schoenobates* with hind-wings broadest at base, and all the other species with narrower hind-wings, whose greatest width is about in the middle. The absence of fork 1 in hind-wing is reminiscent of *Setodellina*, but a gradation occurs in the gradual suppression and final disappearance of the fork. All the species have tibial spurs 2, 2, 2; but in two species, namely *sylvaticus* and *oryx*, the outer spur on the fore tibia is very minute. In those species of which the females are known, the female has forks 1, 3, 5 in the fore-wing.

The larvae with fringed hind legs construct cases of vegetable matter, and are able to swim about, e.g. *schoenobates, harrisoni*. On the other hand, those which construct sand-grain cases have no fringes on the legs and are crawlers, e.g. *scramasax*.

Synopsis of South African species.

1. Hind-wing broadest at base, much broader than fore-wing. Apical fork 1 in hind-wing longer than its stalk.
   - *a.* Hind margin of fore-wing silvery white. Fore-wing 10·5–12 mm. Stalk of M fork in fore-wing very short . . . . . *schoenobates.*
   - *b.* Fore-wing 8 mm. Stalk of M $\frac{2}{3}$ length of the fork . . . . . *fissus.*
2. Hind-wing broadest in middle, not much broader than fore-wing. Species without white on hind margin of fore-wing.
   - *a.* Apical fork 1 in hind-wing present.
     - i. Apical fork 1 in hind-wing long, equal to its stalk . . . . *tabularis.*
     - ii. Apical fork 1 short, not more than $\frac{1}{2}$ length of its stalk. *harrisoni, namaquanus, promontorii, longistylis, cedri, potes, sylvaticus.*
   - *b.* Apical fork 1 in hind-wing absent, or very minute (not more than $\frac{1}{8}$ length of its stalk).
     - i. ♂ genitalia with a single medio-dorsal more or less elongate process. *scramasax, securis, tuckeri, amplexus, corrivalis.*
     - ii. ♂ genitalia without a medio-dorsal process . . *oryx, stephanus, elaphus, caricaria.*

Leptocerus schoenobates n. sp.

(Figs. 21, 22 *a–j.*)

Imago.—Fore-wing with apical fork 1 and apical cell 4 ♂ (cells 4 and 5 ♀), shortly stalked. Hind-wing broadest at base, much broader than fore-wing; apical fork 1 about half as long again as its stalk; stalk of apical cell 4 subequal to cross-vein between Rs and M.

Genitalia ♂, 9th tergite either smooth or with a pair of conical tubercles, which may be either very small, medium, or rather large; preanal appendages apically subacute, setose; 10th tergite a narrow linguiform median process, with lateral subterminal spinulose expansions, and a small setose appendage on either side near base; penis slender, dorsally with 2–3 spines (sometimes 4, occasionally none at all), the terminal portion telescoped in the portion between the spines and capable of being extended to twice its length; claspers 4-branched, the inner branch club-shaped, somewhat volute, forming with its fellow a sheath for the penis, the lower branch rather stout, apically subacute and slightly curved inwards, the other two branches more slender, apically acute. ♀, terminal segment with two low setose bosses dorso-laterally, and ending in a less-strongly chitinised short truncate process, below which are two somewhat globular setose processes, each with an upstanding ridge dorsally, ventrally two squarish flaps and an ovate median process. The penultimate

* Ulmer's figure 370 *c.* (1909A) shows clearly the bipartite trochanter of the fore leg. The same figure is reproduced by Lestage (1921), but his text gives the impression that only the mid and hind trochanters are bipartite.

segment is very broad, the posterior half of the sternite forming an oval or semi-circular flattened surface, smooth and polished, but with a few striae laterally.

Fore-wing 10·5–12 mm. Antennae 25–35 mm.

Head and thorax fawn-brown; head with greyish or fawn hairs in front and white hairs on vertex, thorax with fawn hairs laterally and a broad stripe of white hairs dorsally. Neuration of wings slightly darker than membrane. Fore-wing fawn, with a silvery-white streak along the hind margin, producing a conspicuous

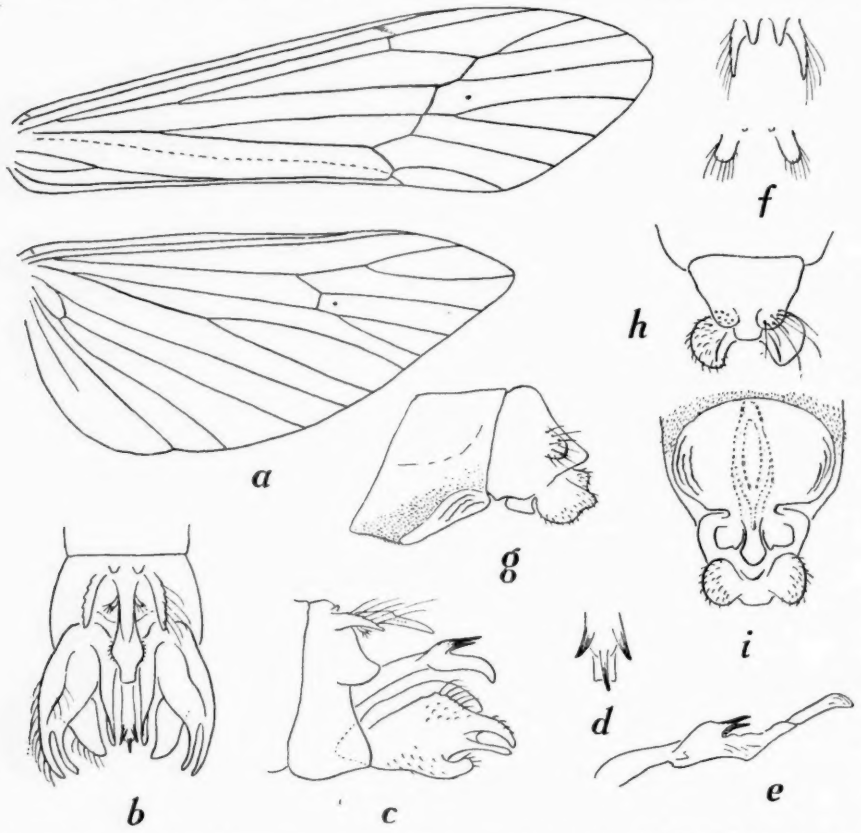

FIG. 21.—*Leptocerus schoenobates* n. sp. *a*, fore- and hind-wings of ♂; *b*, *c*, dorsal and lateral views of genitalia ♂; *d*, dorsal view of three-spined penis; *e*, penis fully extended; *f*, variations of dorsal tubercles, and abnormality of preanal appendages; *g*, *h*, *i*, lateral, dorsal, and ventral views of genitalia ♀.

silvery longitudinal stripe down the wings when in the resting position. Antennae fawn, annulated. Legs ochraceous.

Larva.—Antennae rather long. Labrum with three lateral and two median setae and a pair of rather stout marginal spines. Clypeus with one well-marked and one slight lateral sinuosity. Fore leg with stout spines, sometimes pointed, sometimes blunt as figured; plaque d'appui apically curved upwards, acute. Mid and hind legs with numerous spines, though not always as numerous as figured; hind tibia and tarsus with a double fringe of long setae. No gills. A very fine lateral line on segments 3 to beginning of 8. Anal claws with two accessory denticles.

Up to 18 mm.

Head, pro- and mesonotum, and legs pale horn-colour, head, pro- and mesonotum with darker spots and marks as figured. Abdomen greenish-white.

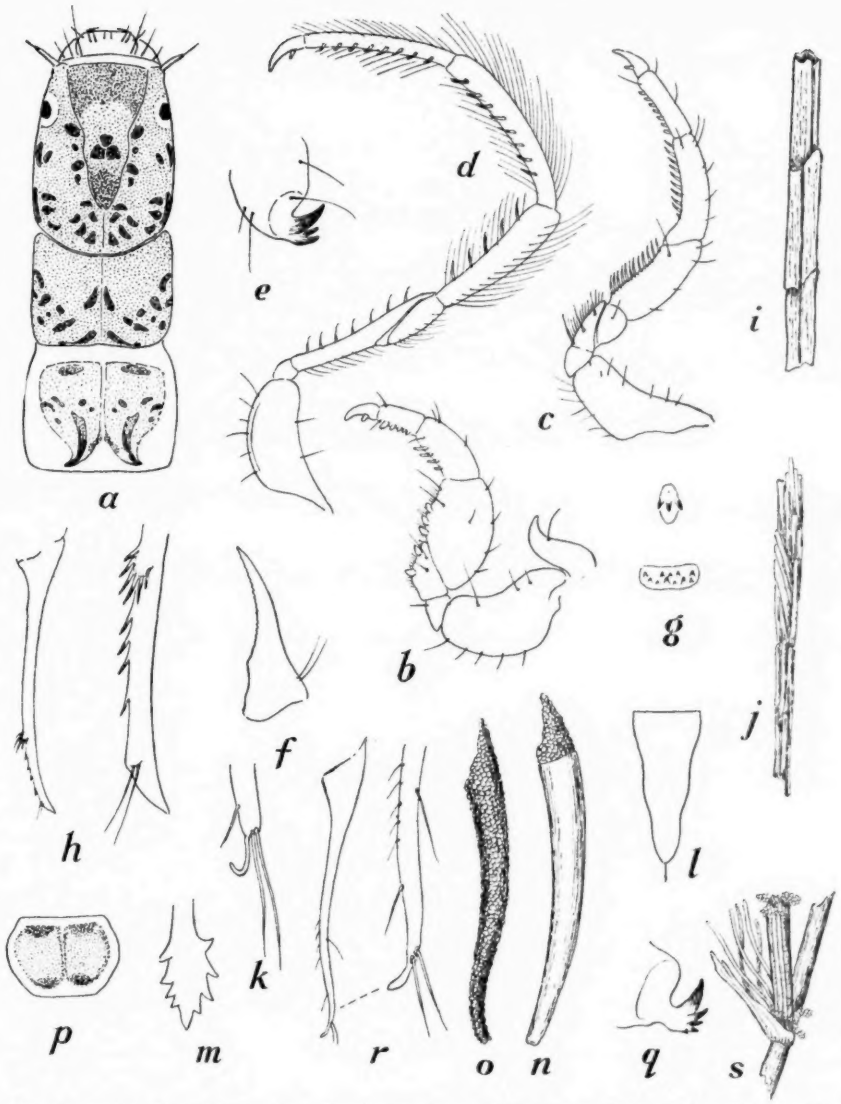

FIG. 22.—*Leptocerus schoenobates* n. sp. *a*, head, pronotum, and mesonotum of larva; *b*, *c*, *d*, fore, mid, and hind legs of larva; *e*, anal holdfast of larva; *f*, mandible of pupa; *g*, dorsal plates of 5th abdominal segment of pupa; *h*, anal appendage of pupa, with distal portion further enlarged; *i*, case made of pieces of green *Scirpus*; *j*, case made of pieces of dead stick and reed. *Leptocerus stephanus* n. sp. *k*, apex of anal appendage of pupa. *Leptocerus* sp. *l*, *m*, *n*, clypeus of larva, apex of anal appendage of pupa, and larval case. *Leptocerus* sp. *o*, larval case. *Leptecho scirpi* n. g., n. sp. *p*, *q*, mesonotum and anal holdfast of larva; *r*, anal appendage of pupa, with apex further enlarged; *s*, pupal case attached to node of *Scirpus*.

Case up to 20 mm. or 25 mm. in length, composed of pieces of *Scirpus* (green), or dead vegetable debris, each piece usually about 10 mm. long. Hind end open. Lives among the living *Scirpus*, growing attached to boulders in the stream.

Pupa.—Labrum semi-circular. Mandible slender, inner margin minutely serrulate. Fore and mid tarsi fringed. 1st abdominal segment as in *harrisoni*. Dorsal presegmental plates with 3–5 spines, postsegmental plates with 8–15 spines. Anal appendages with a projection on inner margin at about ⅓ length, bearing several strong spines, followed by 3–4 more spines, apex acute, with two short subterminal setae. 14 mm.

Case the same as that of larva attached among bases of the tufts of *Scirpus* or other vegetation.

Localities.—Hottentots Holland Mts. (K. H. B., January 1916); Gt. Winterhoek Mts., Tulbagh (K. H. B. and R. M. Lightfoot, November 1916); north side of Matroosberg, Ceres Division (K. H. B. and R. M. Lightfoot, January 1917); Paarl (Gt. Drakenstein), (Rev. Hawke, October 1919); River Zonder End Mts. (K. H. B., November 1928); Du Toit's Kloof, Rawsonville (K. H. B., March 1932); Witte River, Wellington Mts. (K. H. B., November 1922); French Hoek Mts. (K. H. B. and H. G. W., December 1932); Palmiet River (H. G. W., December 1932); Silvermine Valley, Kalk Bay, Cape Peninsula (A. C. H., H. G. W., and K. H. B., March 1933).

Remarks.—This is a very common and widely distributed species, though it appears to occupy a very localised area on the Cape Peninsula. Specimens from various localities show slight variations in the ♂ genitalia, viz. Hottentots Holland Mts. and Ceres, no conical tubercles on 9th tergite; River Zonder End Mts., very small tubercles; Paarl and Du Toit's Kloof, small tubercles; Gt. Winterhoek Mts., strongly developed tubercles.

The name is taken from the habit of the fly in settling on reeds (and other vegetation) and waving its antennae about like the balancing-pole of a tight-rope walker. In the normal resting position the wings are folded down alongside the body and the antennae are laid back over the wings.

Leptocerus fissus Ulmer.

(Fig. 23.)

Ulmer, 1912, p. 108, figs. 36, 37.

Imago.—Fore-wing with the stalks of apical fork 1 and apical cell 4 about half the length of the fork and cell respectively. Hind-wing broadest at base, much broader than fore-wing; apical fork 1 about twice length of its stalk; stalk of apical cell 4 slightly longer than cross-vein between Rs and M.

Genitalia ♂, 9th tergite slightly convex in middle of hind margin, with a transverse patch of minute spinules; preanal appendages elongate, slender, apically setose; 10th tergite rather broad at base with two long,

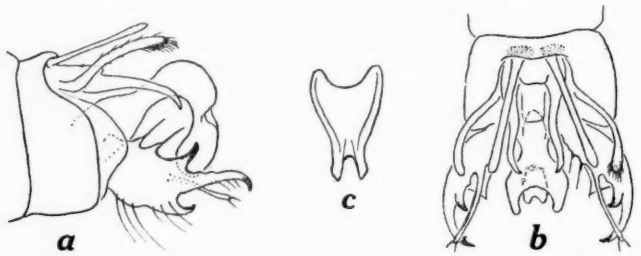

FIG. 23.—*Leptocerus fissus* Ulmer. *a*, *b*, lateral and dorsal views of genitalia ♂; *c*, posterior view of penis.

slender, sinuous processes, and elongate, curved, club-shaped lateral appendages; penis strongly curved, stout, dorsally grooved; clasper with mid-ventral tooth, acutely produced apex, and three spiniform teeth on upper margin, a very slender club-shaped process on inner side.

Fore-wing 8 mm.

Head and thorax dull grey with greyish hairs. Wings grey with very few and scattered white hairs.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, 1 ♂).

Distribution.—Langenburg, Tanganyika Territory (Ulmer).

Remarks.—From the structure of the genitalia one would feel inclined to include this specimen in the genus *Homilia*. The genitalia correspond, however, so closely with Ulmer's figures of *L. fissus* that it must be identified with his species. And as Ulmer records a ♀, caught together with ♂♂, which has the additional fork 3 in the fore-wing (as well as tibial spurs 2, 2, 2), the species must be assigned to *Leptocerus*.

Leptocerus tabularis n. sp.

(Fig. 24.)

Imago.—In fore-wing discoidal cell 2–2¼ times length of apical fork 1, thyridial cell subequal to apical cell 5 ♂ (6 ♀), fork 1 rather more than twice length of its stalk; apical cell 4 in ♂ at least three times length of

its stalk, which is nearly twice as long as cross-vein between Rs and M. In ♀ stalk of M scarcely longer than cross-vein between Rs and M. In hind-wing apical fork 1 subequal to its stalk; stalk of apical cell 4 subequal to cross-vein between Rs and M.

Genitalia ♂, a pair of subovate setose appendages dorsally, a medio-dorsal process, apically spinulose, to which is attached ventrally a pair of processes, each bearing a stout apical spine; a small tubercle carrying two setae at base of median process on either side; penis short and stout, with one pair of titillators and a pair of spines in basal third, only visible when penis fully extended; clasper biramous, the inner branch apically acute and directed upwards and inwards, the outer branch longer, subacute, curving obliquely upwards. ♀, dorsally two pairs of setose patches (scarcely bosses), the median ones smaller than the lateral ones; a

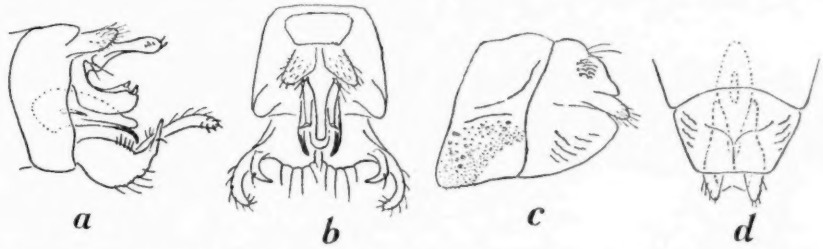

FIG. 24.—*Leptocerus tabularis* n. sp. *a*, *b*, lateral and dorsal views of genitalia ♂, in *a* the left clasper removed; *c*, *d*, lateral and ventral views of genitalia ♀.

dorsal transverse plate, shallowly excised on distal margin; a pair of lateral setose flaps; ventral surface of terminal segment smooth, with fine oblique striae; sternite of penultimate segment with a crescentic transverse area on hind margin, smooth and devoid of pigment.

Fore-wing 6–7 mm.

Head and thorax sepia-brown, with silvery or golden-grey hairs. Wings darkish grey, with scattered golden-grey hairs; a small patch of golden hairs at junction of Cu_2 and the anal veins with hind margin, so that when the wings are folded there is a rather conspicuous spot. Antennae greyish, narrowly and obscurely annulate. Legs grey.

Locality.—Top and upper slopes of Table Mt., Cape Town (K. H. B., February 1919, March, April, 1932, 1933).

Remarks.—This species inhabits the smaller streams and runnels (top of Kasteels Poort and Ark Valley), which, towards the end of summer, are nearly or completely dry. Its larva has not yet been discovered.

Leptocerus harrisoni n. sp.

(Figs. 25, 26.)

Imago.—In fore-wing discoidal cell very long, half as long again as apical cell 2, thyridial cell longer than apical cell 5 (♂), stalk of apical cell 4 (♂) subequal to stalk of fork 1, which is subequal to its fork. In hind-wing apical fork 1 very short, about ⅓ length of its stalk, stalk of apical cell 4 about twice length of cross-vein between Rs and M.

Genitalia ♂, a bilobed setose dorsal plate, below which a transverse emarginate plate, setose at lateral corners, below which another bifid plate; penis simple, with two pairs of titillators, the dorsal pair longer than the ventral pair; clasper lamellate, upper part curving upwards as a broad lobe, ventral part with an upstanding transverse flange across the broad proximal part, and narrowing distally to a subacute apex. ♀, dorsally setose, ending in a thin plate with two points separated by a sinus, below this two lateral setose flaps, ventrally two ovate processes.

Fore-wing 7·5–9 mm.

Head and thorax fulvous-brown or umber, with white hairs. Wings grey-brown, marginal fringe of hind-wing pale grey, white towards anal angle. Antennae and tarsi annulate.

Larva.—Antennae rather long. Clypeus indented in middle of lateral margin. Labrum with lateral patches of setae, two long setae, and a short one on margin. Pronotum chitinous, with dark crescentic mark on hind margin. Mesonotum with quadrangular chitinous plate, which narrows posteriorly. Metanotum membranous, with a narrow chitinous strip running back from base of leg. Plaque d'appui apically curved, blunt, with one seta. Hind tibia and tarsus strongly fringed. Gills completely absent. Anal appendages short, the claw with two denticles. 8–9 mm. Chitinous parts fulvous, head with black marks and spots as in fig. 26 *a*, abdomen creamy-white.

Case cylindrical, composed of pieces of vegetable matter arranged longitudinally; when nearing pupal period gradually changing to a case composed wholly of sand-grains.

Pupa.—Mandible tapering rather rapidly, minutely serrulate. Labrum semi-circular, but slightly produced medianly. Fore and mid tarsi fringed. Dorso-lateral hind corner of abdominal segment 1 with

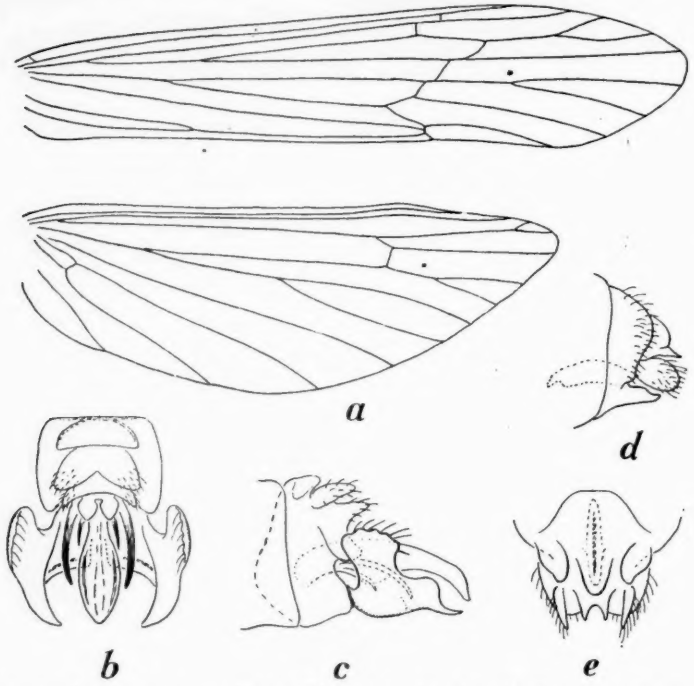

FIG. 25.—*Leptocerus harrisoni* n. sp. *a*, fore- and hind-wings of ♂; *b*, *c*, dorsal and lateral views genitalia ♂; *d*, *e*, lateral and ventral views genitalia ♀.

two chitinous plates set with minute spiniform denticles. Presegmental dorsal plates on segments 3–6, each with 3–4 spines; the postsegmental plate on segment 5 with 8–10 or more spines (in two rows). Gills absent. Anal appendages long, slender, straight, setulose on inner margin, with one long seta on outer margin near apex, the latter somewhat spatulate, with the dorsal and ventral edges minutely serrulate. 6–7 mm.

Case cylindrical, straight, composed of fine sand-grains, closed at both ends by sand-grains, leaving fine open pores in interstices. 9–10 mm.

Localities.—Silvermine Stream, Kalk Bay, and Muizenberg Plateau, Cape Peninsula (A. C. H., K. H. B.); Groot Drakenstein (A. C. H.); Montagu (R. W. E. Tucker, October 1919); Cold Bokkeveld, north of Ceres (K. H. B., September 1932); French Hoek Mts. (K. H. B. and H. G. W., December 1932).

Habits.—The flies have been found from July to January and February. A pupa was found on 24th April, so presumably the season extends to the end of April.

The larvae are of the "swimming-stick" type, and only when they are approaching the pupal stage do they add the sand-grain portion of the case, finally cutting off the vegetable portion entirely.

Leptocerus namaquanus n. sp.

(Fig. 27 *a–d.*)

Imago.—In fore-wing discoidal cell long, but not very much longer than apical cell 2; apical fork 1 nearly twice as long as its stalk; thyridial cell subequal to apical cell 5 (♂); stalk of cell 4 (♂) slightly longer than stalk of fork 1 and twice length of cross-vein between Rs and M. In hind-wing apical fork 1 very short, about $\frac{1}{3}$ length of its stalk; stalk of cell 4 nearly twice length of cross-vein between Rs and M.

Genitalia ♂, dorsally a bilobed setose plate, below which a transverse distally concave plate whose lateral arms bear several short spiniform projections and setae, below this a short plate with median cleft; penis simple, with two pairs of titillators; clasper short, upper margin expanded into a high upstanding lobe. ♀, terminal segment very short and blunt, dorsally ending in two points separated by a shallow excision, laterally a pair of short flaps, ventrally two curved processes; sternite of penultimate segment with smooth bare crescentic area on hind margin.

Fore-wing 6 mm.

Head and thorax fuscous. Wings and antennae similarly coloured, the latter obscurely annulate.

Larva (remains extracted from pupa case).—Clypeus similar in shape and proportions to that of *harrisoni*.

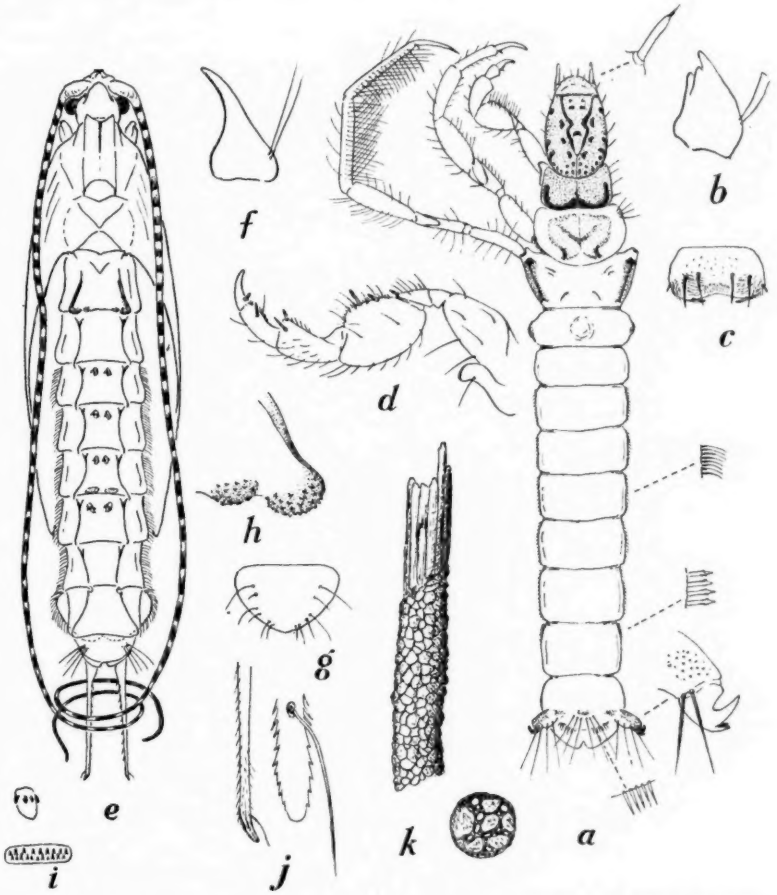

FIG. 26.—*Leptocerus harrisoni* n. sp. *a*, larva, with antenna, anal holdfast, and lateral line further enlarged; *b*, right mandible of larva; *c*, labrum of larva; *d*, fore leg, with plaque d'appui of larva; *e*, pupa; *f*, mandible of pupa; *g*, labrum of pupa; *h*, dorsal scabrosities of 1st abdominal segment of pupa; *i*, dorsal plates of 5th abdominal segment of pupa; *j*, anal appendage of pupa, with external view of tip further enlarged; *k*, pupal case in course of construction, with remains of larval case still attached, and sieve-plate from hind end of pupal case.

Pupa.—Similar to that of *harrisoni*. Presegmental dorsal abdominal plates each with five spines. Anal appendages more slender, tapering evenly, two subapical setae on outer side, apex somewhat spatulate, the dorsal and ventral edges minutely serrulate. 6 mm.

Case cylindrical, straight, composed of fine sand-grains, the ends closed with sand-grains, between which are fine pores.

Locality.—Farm Modderfontein, Kamiesbergen, Namaqualand (K. H. B., September 1931).

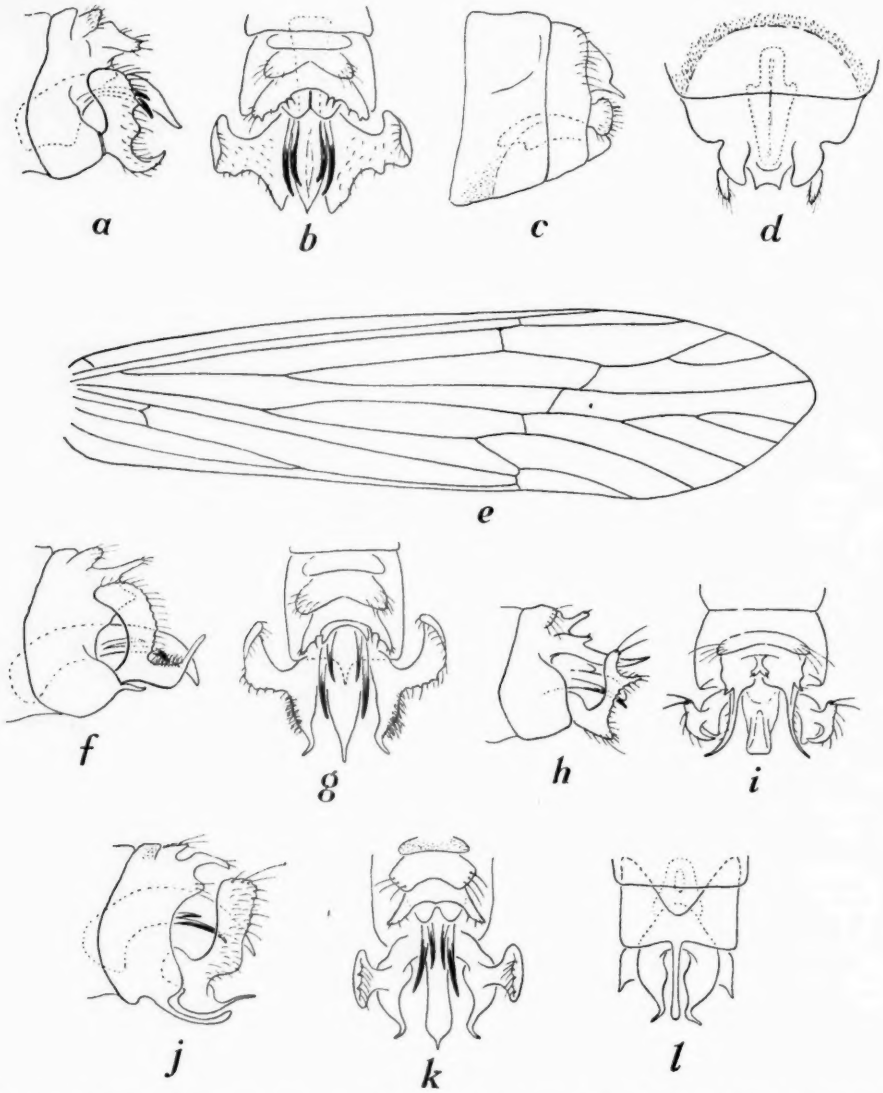

FIG. 27.—*Leptocerus namaquanus* n. sp. *a*, *b*, lateral and dorsal views of genitalia ♂; *c*, *d*, lateral and ventral views of genitalia ♀. *L. promontorii* n. sp. *e*, fore-wing of ♀; *f*, *g*, lateral and dorsal views of genitalia ♂. *L. cedri* n. sp. *h*, *i*, lateral and dorsal views of genitalia ♂. *L. longistylis* n. sp. *j*, *k*, *l*, lateral, dorsal, and ventral views of genitalia ♂.

Leptocerus promontorii n. sp.

(Fig. 27 *e–g.*)

Imago.—In fore-wing discoidal cell 1½ times length of apical cell 2, thyridial cell longer than cell 5 (♂), apical fork 1 longer than its stalk, stalk of apical cell 4 subequal to that of fork 1 and twice as long as cross-vein between Rs and M. In hind-wing apical fork 1 very short, about ⅓ length of its stalk, stalk of cell 4 rather more than twice length of cross-vein between Rs and M.

Genitalia ♂, not unlike those of *namaquanus*, but the lowermost plate ends in two points separated by a wide and shallow excavation; ventral portion of clasper more elongate, ending in an acute point bent outwards and upwards; 9th sternite with sharp median point.

Fore-wing 5·5–6 mm.

Head and thorax fulvous-brown, wings similar, antennae narrowly annulate. Abdomen of ovigerous ♀ green.

Locality.—Paulsberg Plateau, south of Simonstown, Cape Peninsula (A. C. H., June 1931).

Leptocerus longistylis n. sp.

(Fig. 27 *j–l.*)

Imago.—In fore-wing stalk of apical fork 4 subequal to stalk of fork 1, which equals upper branch of fork 1, and is twice, or nearly twice, length of cross-vein Rs–M. In hind-wing apical fork very short, about ⅓ length of its stalk; stalk of apical cell 4 about twice length of cross-vein Rs–M.

Genitalia ♂, very like those of *promontorii*, with slight differences in the 10th tergite, and clasper with the dorsal laminate expansion more upright, not curving anteriorly. 9th sternite with elongate median styliform process, apically slightly enlarged. ♀ similar to that of *namaquanus*, but slightly more elongate.

Fore-wing 7–8 mm.

Head and thorax fuscous or sepia-brown with whitish-grey hairs. Wings brown, with sepia pubescence and scattered pale grey hairs. Legs and antennae fuscous, the latter annulate.

Locality.—Gt. Winterhoek Mts., Tulbagh (K. H. B., September 1932, ♂♂, ♀♀).

Remarks.—A species close to *namaquanus* and more especially *promontorii*, but distinguished by the elongate process on the 9th sternite of ♂.

Leptocerus cedri n. sp.

(Fig. 27 *h, i.*)

Imago.—In fore-wing stalk of apical cell 4 subequal to that of fork 1, and about ⅓ length of upper branch of fork 1. In hind-wing apical fork 1 very short, about ⅓ length of its stalk, stalk of cell 4 subequal to cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse band, laterally setose, followed by a small apically bifid medio-dorsal process; below this a broad plate from which arises on either side a lateral spiniform process bearing near its base a short spur; penis simple, with a pair of titillators; clasper short, upper margin produced in an upstanding bifurcate process. ♀ similar to that of *harrisoni*.

Fore-wing 6·5 mm.

Head and thorax dark sepia-brown, almost blackish, with brown hairs. Wings sepia-brown, with golden-brown hairs. Legs and antennae fuscous, the latter obscurely annulate.

Localities.—Cedar Mts., Clanwilliam District, 4500 feet (K. H. B., September 1923); Cold Bokkeveld Mts., south of Citrusdal, 4000 feet (K. H. B., September 1932).

Leptocerus potes n. sp.

(Fig. 28 *a–g.*)

Imago.—In fore-wing anastomosis between R_{2+3} and Cu_1 straight, slightly oblique; stalk of fork 1 shorter than its fork; apical cell 4 (♂) (4 and 5 ♀) with stalk almost or quite obsolete, thus sessile on the anastomosis. In hind-wing apical fork 1 very short, about ⅓ length of its stalk; stalk of apical cell 4 subequal to cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse plate, setose laterally, slightly emarginate, from lower surface of which depend two curved laminate processes, widening distally, set in a vertical plane; lower down a slender process on either side, apically slightly expanded, with 1–2 setules; penis complex, with hemiwhorl of six (eight in Jonkershoek specimens) stout spines dorsally, apex in lateral view trifid, the lowest lobe recurved ventrally; clasper biramous, outer branch in lateral view widening to midway, then rapidly tapering to a fine incurved point, inner branch arising from base of outer also biramous, its inner branch short, its outer branch slender, tapering, sinuous. ♀ similar to that of *harrisoni*.

Fore-wing 5–6 mm.

Head and thorax dark sepia or blackish, with grey or pale golden hairs. Antennae and legs fuscous, the tarsi sometimes annulate. Abdomen brown, more or less tinged with green. Wing membrane grey, anastomosis in fore-wing clear white, pubescence thick; fore-wing brownish near base, becoming sepia or blackish apically, a white transverse bar from costa to hind margin at level of anastomosis, and some white spots around apical margin, the most conspicuous being that at end of apical cell 3; hind-wing dark sepia.

Localities.—Table Mt., Blinkwater Ravine (lower portion above Camps Bay) (K. H. B., September 1932, ♂♂, ♀♀); Jonkershoek, Stellenbosch (K. H. B., October 1932, ♂♂, ♀♀); Drakenstein (K. H. B., October 1933).

Remarks.—The specific name may be taken in allusion to the erratic flight (which is common in Leptocerids), and the "black and white" coloration, reminding one of a certain brand of "Scotch."

Leptocerus sylvaticus n. sp.

(Fig. 28 *h–j*.)

Imago (in alcohol).—Head and thorax fulvous. Legs and antennae ochreous, the latter faintly annulate. Wing membrane pale buff.

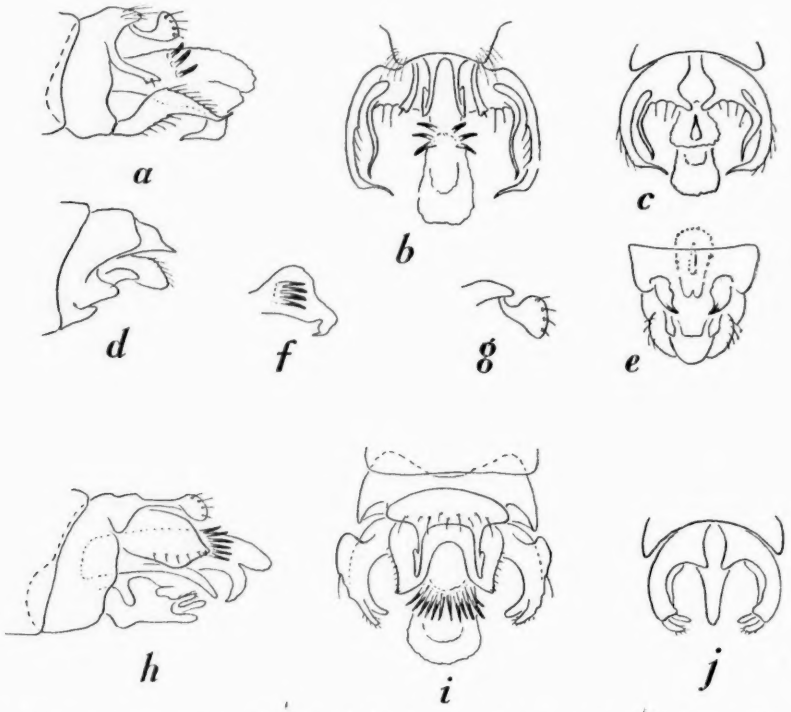

FIG. 28.—*Leptocerus potes* n. sp. *a*, *b*, *c*, lateral, dorsal, and ventral views of genitalia ♂; *d*, *e*, lateral and ventral views of genitalia ♀ (*a–e* Table Mt. specimens); *f*, *g*, penis and one of the dorsal processes from a Jonkershoek specimen. *Leptocerus sylvaticus* n. sp. *h*, *i*, *j*, lateral, dorsal, and ventral views of genitalia ♂.

Fore-wing 5·5 mm.

Venation as in *harrisoni*. Genitalia ♂, dorsally a transverse plate from which project two slender processes with laminately enlarged apices, below this a deeply excised plate (10th tergite) forming an upper penis sheath; penis bilobed apically, with a dorsal hemiwhorl of twelve spines, from the base a linguiform projection or lower penis sheath; clasper with upstanding basal process, apically divided into two prongs, below them a broader (horizontal) projection. ♀ unknown.

Locality.—Oudebosch, River Zonder End Mts. (H. G. W., January 1933, 2 ♂♂).

Remarks.—The fore tibia has only one spur, but under a high magnification a very minute second spur or its scar may be observed.

As regards the genitalia, closely allied to the preceding species *potes*.

Leptocerus scramasax n. sp.

(Fig. 29.)

Imago.—In fore-wing stalk of apical fork 1 subequal to its upper branch, stalk of cell 4 subequal to upper branch of fork 1. In hind-wing apical fork 1 absent, stalk of cell 3 (fork 1 being absent) 1½ times length of cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse band, setose laterally, below this a medio-dorsal knife-like process, dorsal margin thick, ventral margin thin (*scramasax*), below this a transverse plate with a short lobe on each side laterally; penis complex, 3–4 spines on each side, a dorsal membranous lobe, then a pointed process bearing a small lobe on either side, then a broader and longer ventral portion; clasper with ventral portion apically truncate and upturned, upper margin produced in a rather slender bifurcate process. ♀, dorsally with a short rounded point, two slender acute (in lateral view) feebly chitinised processes separated by a narrow sinus, two ovate lateral flaps, and two ventral striate processes, sternite of penultimate segment flat, smooth, but very finely setulose.

Fore-wing 8–10 mm.

Head and thorax fulvous, with greyish or whitish hairs. Wings fawn with slightly darker neuration, and pale fawn hairs. Legs fawn. Antennae grey, annulate. Abdomen (in life) pale green.

Larva.—Antennae shorter than in *harrisoni*. Clypeus with two indents on lateral margin. Labrum and mesonotum as in *harrisoni*. Plaque d'appui oblong, apically blunt, and not curved upwards. Fore leg as in *harrisoni*; hind tibia-tarsus not strongly fringed, only scattered hairs. Gills absent.

Head, pronotum, and mesonotum uniform dark castaneous brown. Legs rather paler. Abdomen creamy-white.

Case tubular, slightly curved, composed of sand-grains, mouth with a dorsal cowl-like projection.

Pupa.—Mandible very slender. Presegmental dorsal plates on segments 3–7, each with 4–6 (or 7) crotchets. Otherwise as in *harrisoni*. Abdomen more or less pale greenish. 6–7 mm.

Case cylindrical, composed of larger sand-grains than the larval case, closed in front and behind by sand-grains with fine pores in the interstices. Fixed in corners and crevices of stones and boulders, or simply in the sand.

Localities.—Cape Peninsula: lower portions of ravines around Table Mt., Kirstenbosch, Platteklip, Blinkwater, etc.; Glencairn; Silvermine Stream, Kalk Bay (K. H. B. and H. G. W., end of August to middle of March); Hottentots Holland Mts. (K. H. B. and H. G. W., January 1933); Jonkershoek, Stellenbosch (K. H. B., October 1932); Palmiet River (H. G. W., December 1932); Oudebosch, River Zonder End Mts. (K. H. B., December 1920 and November 1928, H. G. W., January 1933); French Hoek Mts. (K. H. B. and H. G. W., December 1932); Gt. Winterhoek Mts. (K. H. B. and H. G. W., September and November 1932); Lemoenshoek, Langeberg Range (K. H. B., November 1927).

Remarks.—A widely distributed species, which varies not only in one and the same locality (see fig. 29 *a*, *c*, *d*, *e*), but in different localities (see fig. 29 *a*, *f*, *g*, *h*). These variations, however, are not great enough to justify varietal names.

The species is one of our commonest Leptocerids, and the flies may be found from the end of August up to the middle of March.

The larvae are crawlers, not swimmers like those of *harrisoni*, and although they usually construct their own cases of sand-grains, they occasionally utilise foreign objects or other Caddis-cases (see fig. 29 *o*, *p*). The cowl-like projection over the head, however, is always added.

The rate of growth during the winter is much slower than during the summer months. At the beginning of April larval cases measuring about 2–3 mm. are found, but a few are large, up to 5–6 mm.

Leptocerus securis n. sp.

(Fig. 30 *a*, *b*.)

Imago.—In hind-wing apical fork 1 absent, stalk of cell 3 twice length of cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse band, setose laterally, below this a slender medio-dorsal process, somewhat thickened dorsally, below this a subcircular plate with a large and deep rounded excavation; penis complex, dorsally with a transverse row of six spines followed by a pair of spines, a dorsal pale process, then a ventral pale bilobed process, flanked on either side by a bifurcate chitinous process (titillator); clasper apically produced in an upcurved and incurved process, dorsal margin produced in a bifurcate process.

Fore-wing 9 mm.

Head and thorax fulvous with buff hairs. Wings yellowish-brown or fawn. Legs fawn. Antennae greyish-buff, annulate.

Localities.—Gt. Winterhoek Mts., Tulbagh (K. H. B. and R. M. Lightfoot, November 1916, and K. H. B., September and November 1932); Hottentots Holland Mts. (K. H. B., January 1916).

Remarks.—The Hottentots Holland Mts. specimens are similar to those from the Gt. Winterhoek Mts., but smaller (fore-wing 6 mm.), and with the dorsal process of the ♂ genitalia more stumpy, the wings more greyish, and the antennae not, or only very obscurely, annulate.

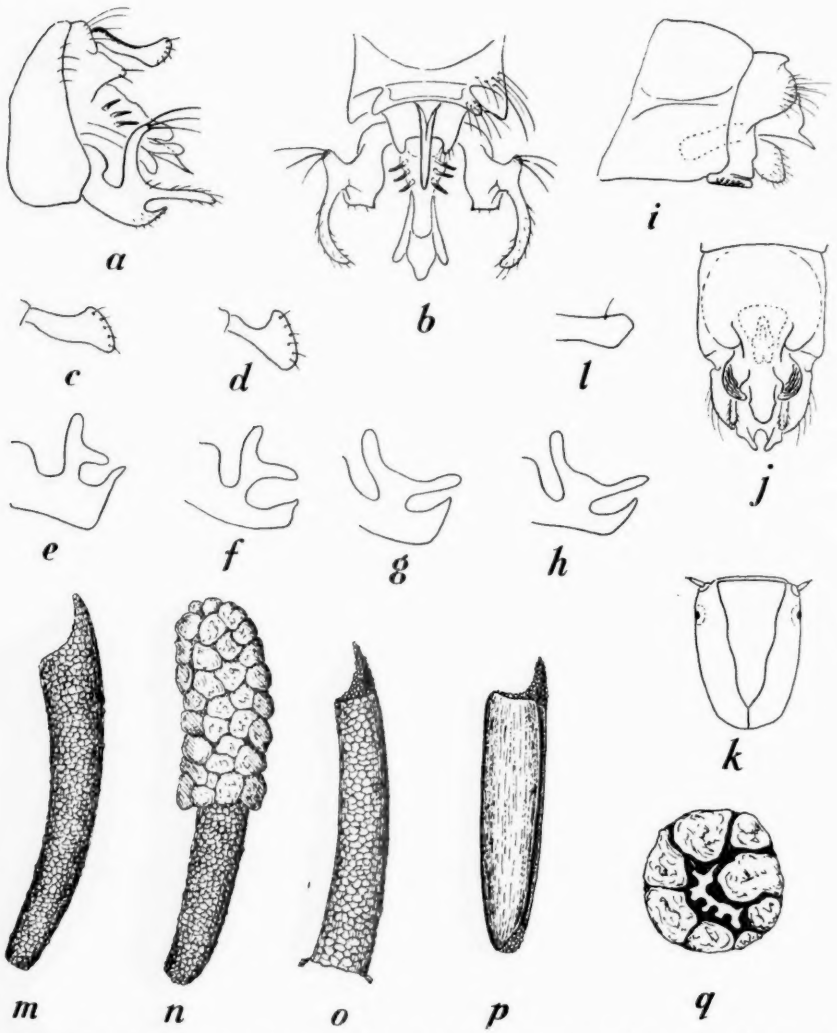

FIG. 29.—*Leptocerus scramasax* n. sp. *a*, *b*, lateral and dorsal views ♂ genitalia; *c*, *d*, varieties of dorsal process (*a–d* Cape Peninsula specimens); *e*, *f*, *g*, *h*, varieties of clasper from Kirstenbosch, River Zonder End, Gt. Winterhoek, and Lemoenshoek respectively; *i*, *j*, lateral and ventral views ♀ genitalia; *k*, dorsal view of head of larva; *l*, plaque d'appui of larva; *m*, normal larval case; *n*, pupal case in course of construction; *o*, pupal case of *Petroplax caricis* taken possession of by larva of *L. scramasax*, with cowl added; *p*, bract of reed (*Restio*) utilised by larva, with cowl added, and hind end closed with sand-grains; *q*, hind end of pupal case.

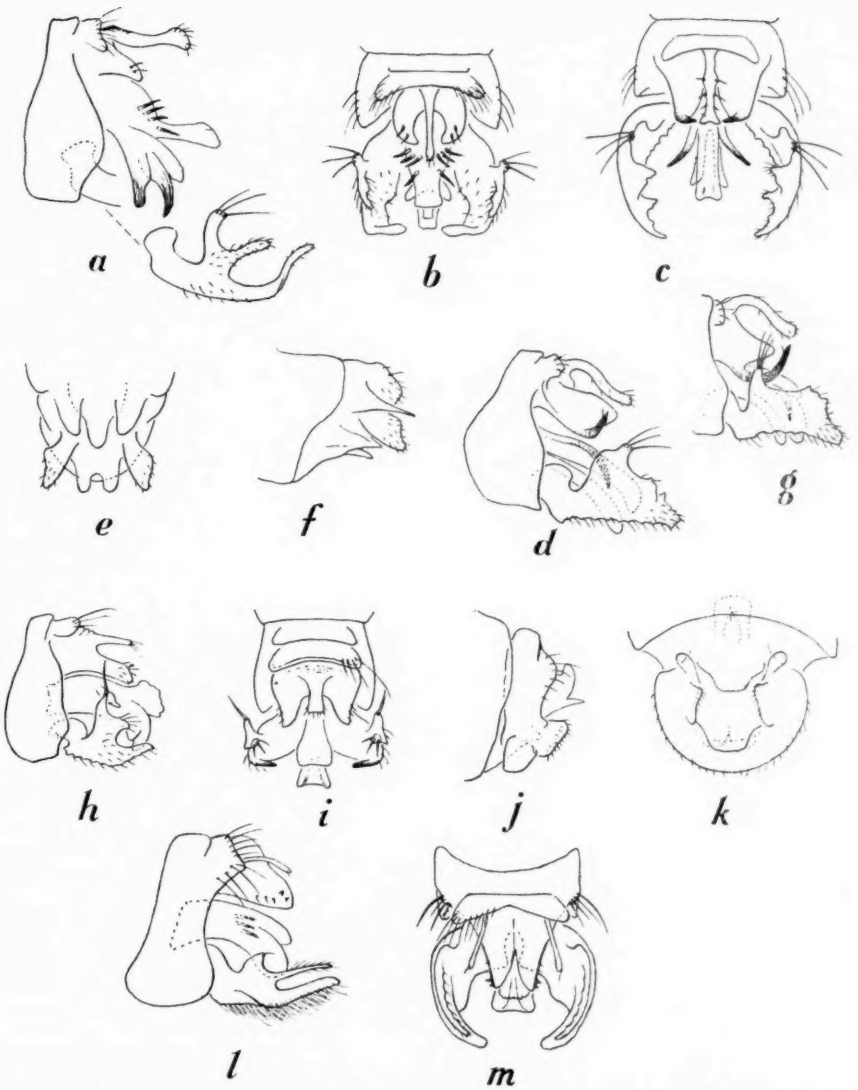

FIG. 30.—*Leptocerus securis* n. sp. *a*, *b*, lateral and dorsal views ♂ genitalia, clasper in *a* displaced. *L. tuckeri* n. sp. *c*, *d*, dorsal and lateral views ♂ genitalia, specimen from Montagu; *e*, *f*, ventral and lateral views ♀ genitalia; *g*, lateral view ♂ genitalia, specimen from Jonkershoek. *L. amplexus* n. sp. *h*, *i*, lateral and dorsal views ♂ genitalia; *j*, *k*, lateral and ventral views ♀ genitalia. *L. oryx* n. sp. *l*, *m*, lateral and dorsal views ♂ genitalia.

Leptocerus tuckeri n. sp.

(Fig. 30 *c–g.*)

Imago.—In fore-wing stalk of apical cell 4 subequal to stalk of apical fork 1, which is subequal to length of upper branch of fork. In hind-wing apical fork 1 absent or very small, stalk of cell 3 subequal to, or slightly shorter than, cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse band, with a few setae laterally, a medio-dorsal process, in lateral view sigmoid, in dorsal view with lateral tubercles and apically slightly expanded and truncate, below this a broad plate with median incision, each half with a strong chitinous spinous process curving upwards and inwards; penis simple, with a pair of titillators, and also a pair of subpenial processes arising near its base; clasper antler-like, the lower margin scalloped, the upper margin irregular, with three main projections; 9th sternite ending in a small rounded point. ♀ similar to that of *harrisoni*, lateral setose flaps apically obliquely truncate.

Fore-wing 7–7·5 mm.

Head and thorax castaneous with golden-brown hairs. Wings pale brown, with darker neuration, and greyish hairs. Legs and antennae fawn, the latter annulate.

Localities.—Montagu, Cape Province (R. W. E. Tucker, October 1919, 2 ♂♂); Jonkershoek, Stellenbosch (K. H. B. and H. G. Wood, February 1933, ♂♂, ♀♀); Elands Kloof, Citrusdal (H. G. W., March 1933, ♂, ♀♀).

Remarks.—Named after Mr. R. W. E. Tucker, a very keen field collector, and formerly a member of the staff of the South African Museum, and now Chief Entomologist, Barbados.

The Citrusdal specimens are somewhat intermediate, but resemble the Montagu rather than the Jonkershoek specimens.

Leptocerus amplexus n. sp.

(Fig. 30 *h–k.*)

Imago.—In fore-wing stalks of apical fork 1 and apical cell 4 subequal to one another, and half length of upper branch of fork 1. In hind-wing apical fork 1 absent (or extremely minute), stalk of apical cell 3 subequal to cross-vein between Rs and M.

Genitalia ♂, dorsally two transverse bands, the distal one setose laterally, followed by a medio-dorsal, short, rather stout, process, below this a plate ending in two points separated by a wide sinus; penis simple, divided into a dorsal and ventral lobe, with a short lateral process (not strongly chitinised) on either side; clasper short, ventral portion ending in an incurved point, upper margin produced in a short, stout, bifurcate process. ♀ similar to that of *harrisoni* and *namaquanus* in general, but the setose flaps more ventral in position.

Fore-wing 7 mm.

Head and thorax dark sepia-brown with greyish hairs. Wings grey-brown, neuration darker, with brown hairs. Legs and antennae sepia-grey, the latter faintly annulate.

Locality.—Zuur Vlakte, Wellington Mts. (K. H. B., November 1922, ♂, ♀).

Leptocerus corrivalis n. sp.

(Fig. 31 *a–c.*)

Imago.—In fore-wing apical fork 1 longer than its stalk; stalk of M scarcely as long as that of fork 1, and subequal to, or very slightly longer than, cross-vein between Rs and M. In hind-wing apical fork 1 absent (a mere thickening of the vein at the margin); stalk of apical cell 3 subequal to cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse band, setose laterally, and with a median pointed process, below which is a plate ending in two fairly broad, apically obliquely truncate and pointed processes separated by a deep sinus; penis simple, three spines on either side which are not apparent until the penis is extended, and also a pair of titillators; clasper ovate, spoon-shaped, with two lobes on dorsal margin.

Fore-wing 5·5 mm.

Head and thorax castaneous brown. Wings pale grey. Legs and antennae pale fuscous (specimen in alcohol, hairs rubbed off).

Locality.—Silvermine Stream, Kalk Bay, Cape Peninsula (A. C. H., July 1931, 1 ♂).

Leptocerus oryx n. sp.

(Fig. 30 *l, m.*)

Imago.—In fore-wing stalk of fork 1 slightly shorter than upper branch of fork, and subequal to stalk of M, which is very slightly longer than cross-vein between Rs and M. In hind-wing apical fork 1 minute but distinct, stalk of apical cell 4 subequal to cross-vein between Rs and M. Outer tibial spurs shorter than inner, that on fore leg minute.

Genitalia ♂, a dorsal transverse plate, setose laterally; preanal appendages slender; 10th tergite ridge-like, keeled proximally, distally bilobed, each lobe bearing 1–2 short stout spines and a few setae apically; penis in lateral view bifid, with 3–4 spines visible when extended, no titillators; clasper proximally spoon-shaped, apically narrowed, with a bifurcate process on upper margin, the lower branch of the fork elongate and slender. ♀ unknown.

Fore-wing 6 mm.

Head and thorax fulvous with fawn-coloured hairs. Legs and antennae ochreous, the latter annulate. Wings brown with fawn pubescence on fore-wing, grey on hind-wing.

Locality.—Elands Kloof, Citrusdal (Olifants River Mts.), (H. G. W., March 1933, 1 ♂).

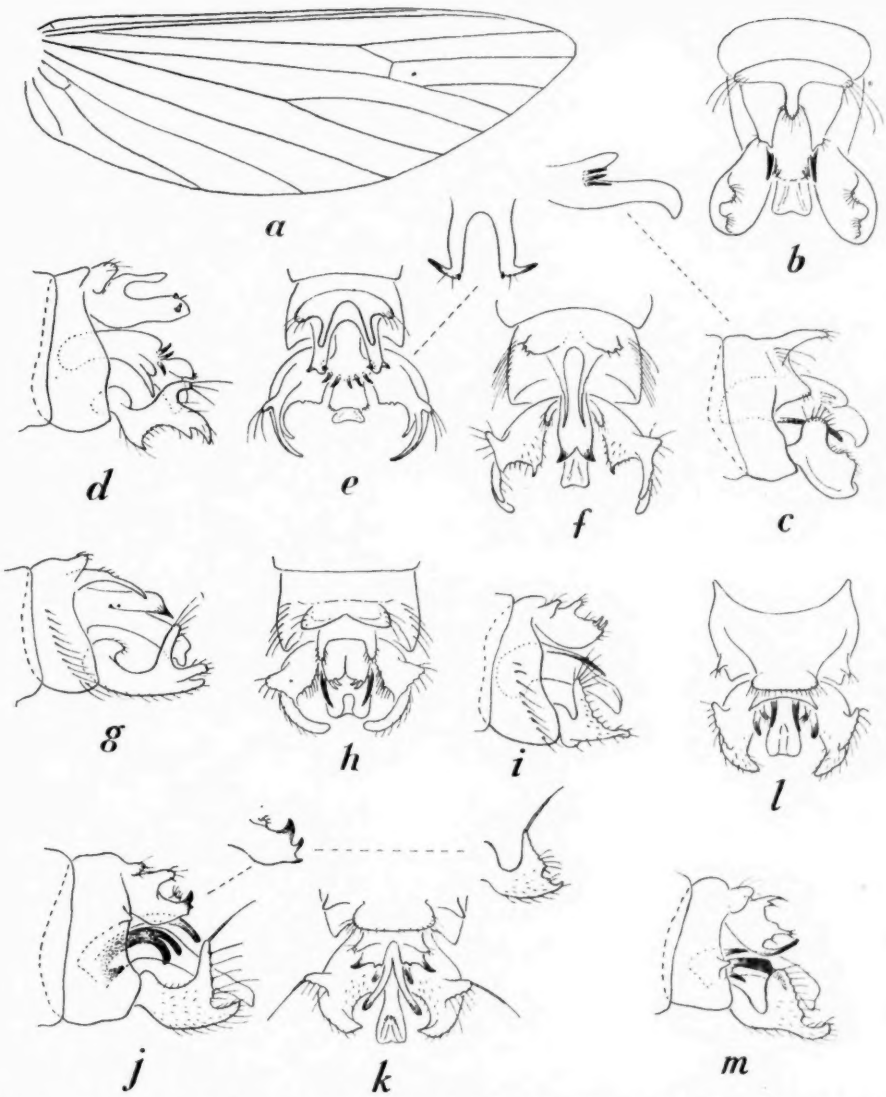

FIG. 31.—*Leptocerus corrivalis* n. sp. *a*, hind-wing; *b*, *c*, dorsal and lateral views ♂ genitalia, with penis extended. *L. stephanus* n. sp. *d*, *e*, lateral and dorsal views ♂ genitalia of specimen from River Zonder End, with dorsal view of 10th tergite of specimens from Montagu Pass. *L. elaphus* n. sp. *f*, *g*, dorsal and lateral views ♂ genitalia. *L. caricaria* n. sp. *h*, *i*, dorsal and lateral views ♂ genitalia. *Leptecho scirpi* n. g., n. sp. *j*, *k*, lateral and dorsal views ♂ genitalia (Table Mt.), with variation in 10th tergite and clasper (Gt. Winterhoek Mts.). *L. lupi* n. sp. *l*, *m*, dorsal and lateral views ♂ genitalia.

Leptocerus stephanus n. sp.

(Figs. 22 *k*, 31 *d*, *e*.)

Imago.—In fore-wing stalk of apical cell 4 subequal to stalk of apical fork 1, which is half length of upper branch of fork 1. In hind-wing apical fork 1 absent, stalk of apical cell 3 slightly longer than cross-vein between Rs and M.

Genitalia ♂, dorsally a transverse band, laterally setose, medianly produced in two slender processes, below these two stout processes (10th tergite) separated by a deep sinus, each process apically with a small conical tubercle on inner upper side and a short stout spine on outer surface; penis complex, dorsally with a hemiwhorl of 5–6 spines, distally divided into dorsal and ventral lobes, the former slightly bilobed and with a few fine setules apically, ventrally a pair of bifid titillators; clasper in lateral view with lower margin excised and with a subapical tooth, apex acute, dorsal margin with short forwardly curving process. ♀ similar to that of *tuckeri*.

Fore-wing 8–8·5 mm.

Head and thorax fulvous with fawn-coloured hairs. Wings brown with light golden-brown hairs. Legs and antennae fawn, the latter obscurely annulate.

Larva.—Similar to that of *scramasax*, the antennae, however, rather long, as in *harrisoni*. Clypeus bisinuate laterally. Mesonotal shield larger and more quadrangular than in *harrisoni*. Inner femoral margin of fore leg with close-set short spinules. Hind tibia-tarsus not fringed. Anal holdfast with three accessory denticles. 8–9 mm.

Head, pronotum, mesonotum, legs, and other chitinised parts uniform dark castaneous brown, metanotum and abdomen creamy-white.

Case tubular, composed of sand-grains and more or less completely covered on outside with small bits of vegetable debris, usually 2–3 bits projecting in front, forming a cowl over the head. Up to 12–13 mm.

Pupa.—Mandible slender as in *scramasax*. Presegmental dorsal plates on segments 3–6 as in *harrisoni*. Anal appendages very slender, apex of each with a short subterminal seta, two long apical setae, and a stout uncinate spine (fig. 22 *k*).

Case cylindrical, composed of sand-grains, of slightly wider diameter than the larval case, and not covered with vegetable debris, ends closed with sand-grains with fine pores in the interstices. 9–10 mm. Affixed to stones with the head end downwards, usually gregarious.

Localities.—River Zonder End Mts., 1500 feet (K. H. B., January 1919, 1 ♂); Montagu Pass, N. of George, Outeniqua Range, 1000–2000 feet (H. G. W., April 1933, ♂♂, ♀♀, larvae, and pupae).

Remarks.—The lateral spine on the 10th tergite in the ♂ genitalia is much larger and more prominently outstanding in the Montagu Pass specimens than in the single specimen from River Zonder End.

Leptocerus elaphus n. sp.

(Fig. 31 *f*, *g*.)

Imago.—In fore-wing stalk of apical fork 1 and apical cell 4 $\frac{1}{2}$–$\frac{2}{3}$ length of upper branch of fork 1. In hind-wing apical fork 1 absent, stalk of apical cell 3 subequal to cross-vein between Rs and M.

Genitalia ♂, dorsally a pair of ovate setose plates, medianly two slender curved processes; penis simple, apically divided into dorsal and ventral lobes, the bifid apices of the former rather strongly chitinised; no titillators; clasper antler-like, the lower median portion ending in a sharp point, dorsal margin with slender upstanding process (in the Gt. Winterhoek specimens longer than in the Hottentots Holland specimen), apex bifid, basal projection rounded or acute; 9th sternite ending in a very small median point. ♀ as in *harrisoni*.

Fore-wing 9 mm.

Head and thorax dark fawn, with greyish or buffish hairs. Wings fawn with buffish hairs. Legs and antennae fawn, the latter obscurely annulate.

Localities.—Hottentots Holland Mts. (K. H. B., January 1916, and K. H. B. and H. G. W., January 1933); Gt. Winterhoek Mts., Tulbagh (K. H. B. and R. M. Lightfoot, April 1916, and K. H. B., November 1932).

Leptocerus caricaria n. sp.

(Fig. 31 *h*, *i*.)

Imago.—In fore-wing stalk of apical cell 4 subequal to that of apical fork 1, which is $\frac{2}{3}$ length of upper branch of fork 1. In hind-wing apical fork 1 absent, stalk of apical cell 3 twice length of cross-vein between Rs and M.

Genitalia ♂, dorsally a bilobed transverse plate, laterally setose, below this a plate bearing dorsally two widely separated processes, and divided medianly by a short cleft into two lobes, each bearing two apical spines; penis simple, upper lobe with a pair of titillators; clasper short, triangular in lateral view, apex incurved, subacute, upper margin produced in an apically subacute process. ♀ unknown.

Fore-wing 5–6 mm.

Head and thorax dark sepia with grey hairs. Wings sepia-brown, with slightly golden-brown hairs. Legs light fawn, antennae sepia, both uniform, not annulate.

Localities.—Hottentots Holland Mts., 3500 feet (K. H. B., January 1916); Lemoenshoek, Langeberg Range, Heidelberg, Cape, 2000 feet (K. H. B., November 1927); French Hoek Mts. (H. G. W., Oct. 1933, ♂♂).

Leptecho n. g.

Imago.—Resembling *Leptocerus* in tibial spur formula, viz. 2, 2, 2; and *Homilia* in having the same venation of fore-wing in both sexes, viz. forks 1 and 5 only. Fork 1 absent in hind-wing as in *Setodellina*.

Larva.—Fore leg without stout spines. Hind tibia and tarsus fringed. Gills absent. Case cylindrical, composed of one series of short lengths of living vegetable matter (*Scirpus*).

Pupa.—Presegmental dorsal abdominal plates on segments 3–6, postsegmental also on segment 5. Anal appendages slender, apex of each ending in a spatulate process and two long setae.

Case the same as that of larva, both ends closed with membrane with oval central aperture, and in addition a few pieces of moss or other vegetation.

Remarks.—In addition to the two species included in this genus, the species *caricaria* may also belong here in view of the similarity in the ♂ genitalia. At present it is only known in the ♂ sex, and is referred provisionally to *Leptocerus*.

Genotype: *L. scirpi* n. sp.

Leptecho scirpi n. sp.

(Figs. 22 *p–s*, 31 *j*, *k*.)

Imago.—Genitalia ♂, dorsally a transversely oval plate (9th tergite), 10th tergite or upper penis sheath in lateral view excised, the apex of lower lobe acute, spiniform; penis simple, with a pair of elongate dorsal titillators, and a pair of ventro-lateral processes, each of the latter with bifid apex and a tooth on lower margin at base; clasper short, apex incurved, acute, upper margin with subtriangular process; ♀ as in *L. harrisoni*, but the lateral flaps more prominent.

Fore-wing 7·5–8 mm.

Head and thorax fulvous with white hairs. Wings fawn, fore-wing with pale brown pubescence, paler and more golden on the costal margin, with a speckling of white hairs forming a triangular patch from base of thyridial cell and widening towards tip of wing, fringes of hind-wing pale fawn. Legs pale buff. Antennae white (or pale buff) and brown, annulate.

Larva.—Clypeus narrow, with two slight indentations laterally. Mesonotum with two contiguous feebly chitinised plates dorsally, each of which has a slightly more strongly chitinised patch on front and hind margins. Fore leg as in *L. harrisoni*, but plaque d'appui apically blunt. Abdominal segment 8 with very few lateral spinules (*cf.* fig. 26 *a*) or none. Anal holdfasts each with 3–4 denticles in addition to the main claw.

Head, pronotum, and mesonotum light fulvous or ochraceous, the head uniform.

Case about 10 mm. long, composed of pieces of living *Scirpus* arranged in a single series.

Pupa.—See under genus and fig. 22 *r*, *s*.

Localities.—Table Mt. (Echo Valley and Orange Kloof), (K. H. B., March 1933, larvae, pupae, ♂♂, ♀♀); Kalk Bay Mts. (Reservoir and Silvermine Valley), (K. H. B. and A. C. H., January 1932, larvae); Hottentots Holland Mts. (K. H. B., January 1933, larvae); Gt. Winterhoek Mts. (R. M. Lightfoot, April 1916, 2 very mutilated ♂♂).

Remarks.—The Gt. Winterhoek specimens are hopelessly mutilated except for the genitalia, which show slight variations from the Table Mt. form (fig. 31 *j*, *k*).

Leptecho lupi n. sp.

(Fig. 31 *l*, *m*.)

Imago.—Genitalia ♂, similar in general to those of *scirpi*, but differing in the shape of the processes below the dorsal plate, and of the claspers. A lateral spinous point on either side as in *scirpi*, but situated farther ventrally. Dorsal titillators short; ventral processes with tooth on lower margin near base and entire acute apices. ♀ similar to that of *harrisoni*, lateral flaps prominent.

Fore-wing 6–6·5 mm.

Head and thorax sepia brown. Wings fawn-brown with slightly darker neuration. Legs and antennae ochraceous.

Locality.—Wolvenhoek Kloof, French Hoek (K. H. B., April 1931, ♂♂, ♀♀).

Uncorrelated Leptocerid larvae and cases.

(Fig. 22 *l*, *m*, *n*.)

A crawling larva similar in colour and structure to that of *L. scramasax* and widely distributed.

The case is an "elephant-tusk" case composed entirely of secreted silk, but with an added cowl of sand-grains. It is suspected that these cases are not actually made by this larva, but are really discarded cases made by the larvae of *Hydrosalpinx* (p. 321).

When pupating they behave like the larvae of *scramasax*, gradually adding the sand-grain case while burrowing into patches of soft sand, finally discarding the larval tube. Early in November 1932 in the Gt. Winterhoek Mts. these larvae were found burrowing into patches of sand and pupating in some spots in such numbers that a patch of sand amongst stones, 2–6 inches in diameter, became a matted mass of pupal cases. Unfortunately, none were bred.

Pupa as in *scramasax*, but with rather more widely expanded spatulate apices to the anal appendages.

(Fig. 22 *o*.)

A crawling larva similar to that of *scramasax*, but the clypeus with only a single lateral indent.
Case like a very slender cornucopia, composed of fine sand-grains 7 mm. in length.
Gt. Winterhoek Mts., November 1932, and Hottentots Holland Mts., January 1933.

Gen. *Leptocerina* Mosely.

Mosely, 1932, p. 297.

Imago.—Like *Leptocerus*, but in fore-wing apical cell 4 (♂) (in ♀ 4th and 5th) sessile, reaching anastomosis, and in hind-wing apical cell 4 sessile, the cross-vein from R_{4+5} joining M *after* the latter forks.

Remarks.—Mosely includes in this genus: *niveicornis* Ulmer, from the Gold Coast, *ramosus* Ulmer from Cameroon, *spinigera* Mosely from Sierra Leone, *mlanjensis* Mosely from Nyassaland, Ashanti, and Sierra Leone, *furcata* Mosely from Kericho, East Africa, and *simulans* Mosely from Elizabethville. He adds that possibly other African "Leptocerus" species should be included. One of these seems to be *connexus* Navas, 1930, from the Belgian Congo, and *ugandanus* Ulmer, 1931, from Uganda is another. *L. furcata* Mosely appears to be very near to, if not synonymous with, *ugandanus* Ulmer.

L. mlanjensis falls within the region here considered.

Gen. *Oecetis* McLach.

Ulmer, 1907, p. 142; 1922, pp. 59 *sqq.*; 1923, pp. 9 *sqq.*; 1930, p. 495; 1931, p. 22. Navas, 1930A, p. 335; 1931A, p. 142. Lestage, 1919A, p. 318; 1921, p. 639 (larva and pupa).

Imago.—Tibial spurs 1, 2, 2 or 0, 2, 2. Wings narrow. In fore-wing discoidal cell often very long and narrow, apical forks 1, 5 (♂, ♀), fork 1 acute or stalked, thyridial cell (usually) very long and narrow, M simple. In hind-wing apical forks 1, 5, fork 1 short, 4th apical cell stalked. Genitalia ♂, claspers 1-jointed.

Larva.—Head oval. Antennae long, distal joint with apical seta. Maxillary palp very long. Mandible knife-like. Hind leg longest. Hind tibia of a single piece. Lateral line very fine. Gills simple.

Case straight or curved, composed of sand-grains or vegetable debris.

Pupa.—Tibial spurs 1, 2, 2 or 0, 2, 2. Labrum with numerous setae and a more or less produced median projection on distal margin. Presegmental dorsal plates on segments 3–7. Gills present.

Case the same as that of the larva.

Remarks.—The genus is world-wide in distribution. The African species are *fasciata* Lest., *pangana* Navas, and *hulstaerti* Navas, from Belgian Congo, *virgata* Ulmer from Usambara, *setifera* Ulmer, *maculipennis* Ulmer, *gradata* Ulmer, *appendiculata* Ulmer, all from the Sudan, *montana* Ulmer from Abyssinia, and *acuta* Ulmer from Natal. *O. gradata* has also been recorded from Mozambique.

Two more species from South West Africa are here added.

Key to the South African species.

1. 5th apical cell in fore-wing sessile.
   a. Cross-vein between M and Cu_1 directed downwards and distally . . . . *acuta*.
   b. Cross-vein directed downwards and proximally . . . . . *kunenensis*.
2. 5th apical cell stalked.
   a. Sc and R in fore-wing separate . . . . . *ovampoensis*.
   b. Sc and R fused . . . . . *gradata*.

Oecetis acuta Ulmer.

Ulmer, 1931, p. 22, fig. 23 (genitalia ♂).

Imago.—Tibial spurs 1, 2, 2. In fore-wing none of the apical cells stalked. The three cross-veins of the anastomosis step-like, the lowest one (that between M and Cu_1) directed downwards and distally.

Genitalia ♂, 9th tergite medianly produced in a rounded triangular process; preanal appendages short, straight, apically rounded; 10th tergite similar in shape to that of 9th; clasper slender, curved inwards and upwards, apex acute.

Fore-wing 5 mm.

Head and thorax yellow-brown. Wings grey-brown with yellow-brown hairs. Legs yellowish. Antennae pale yellowish-white, with narrow dark annulations at least in basal half.

Locality.—Weenen, Natal (Ulmer).

Oecetis kunenensis n. sp.

(Fig. 32 *a–d*.)

Imago.—Fore legs and maxillary palps broken off. In fore-wing no apical cell stalked. Anastomosis step-like, 2nd cross-vein nearly twice its length from 1st, 3rd arising almost at 2nd and slanting downwards and proximally. In hind-wing a slight indication of an accessory vein above Cu_1 (cf. *Setodes*).

Genitalia ♀, terminal segment with two minute knobs above the plate, which in dorsal view is semi-circular and apically notched, and in lateral view ends in a point, below this two ovate flaps whose lower margin is curved inwards, distal margin of sternite slightly produced.

Fore-wing 5·5 mm.

Head and thorax pale brown, hairs abraded. Wing membranes uniform pale brown, venation darker, hairs abraded. Legs and antennae pale greyish.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, 1 ♀ mutilated).

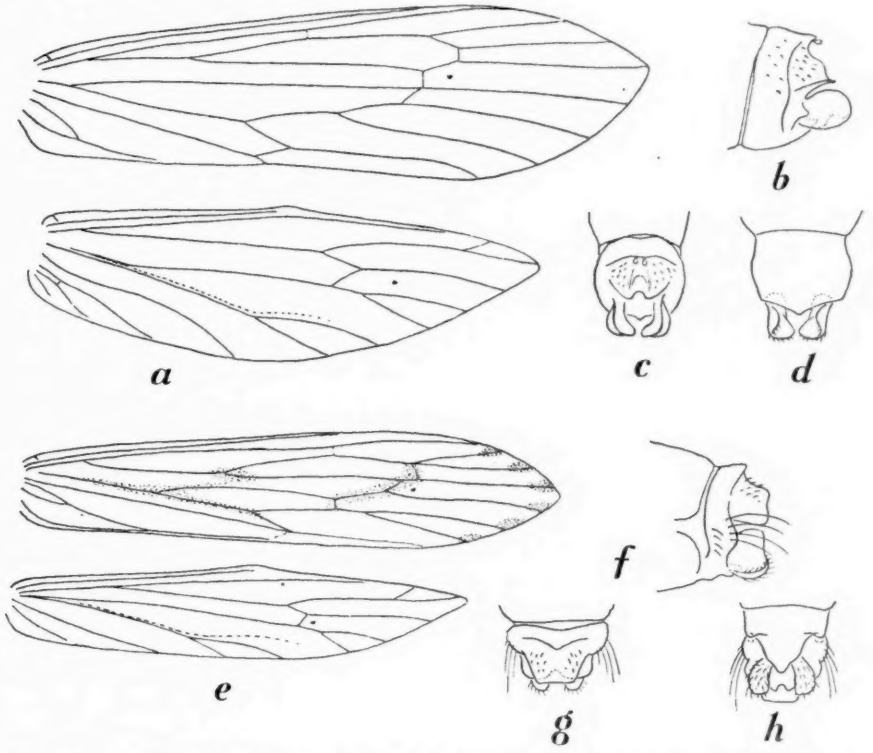

FIG. 32.—*Oecetis kunenensis* n. sp. *a*, fore- and hind-wings· *b*, *c*, *d*, lateral, dorsal, and ventral views ♀ genitalia. *Oecetis ovampoensis* n. sp. *e*, fore- and hind-wings; *f*, *g*, *h*, lateral, dorsal, and ventral views ♀ genitalia.

Oecetis ovampoensis n. sp.

(Fig. 32 *e–h*.)

Imago.—Tibial spurs 1, 2, 2. Maxillary palp, 1st joint short, 2nd, 4th, and 5th subequal, 3rd longest. In fore-wing apical cell 5 stalked, cell 1 acute at base. Anastomosis more irregular, 2nd cross-vein oblique, 3rd straight but some little distance proximal to 2nd. Thyridial cell slightly shorter than discoidal cell. In hind-wing a slight indication of an accessory vein above Cu_1.

Genitalia ♀, terminal segment trapezoidal dorsally, truncate in dorsal and lateral views, below this two short blunt flaps whose lower margin is curved outwards, sternite triangularly produced.

Fore-wing 5·5 mm.

Head and thorax fulvous with pale ochraceous hairs. Legs and antennae ochraceous. Wing membrane pale brown with slightly darker venation. In fore-wing the anastomosis, base of discoidal cell, greater part of Cu_1, and patches on apical margin suffused with darker brown (fig. 32 *e*); hairs greyish or pale brown, with darker brown patches corresponding with the suffused areas on the membrane.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, 1 ♀).

Oecetis gradata Ulmer.

Ulmer, 1923, p. 9, figs. 26–28; Mosely, 1932D, p. 4.

Imago.—Tibial spurs 1, 2, 2. Maxillary palp, 1st joint shortest, 2nd longer, 3rd still longer, 4th subequal to 2nd, 5th subequal to 3rd. In fore-wing Sc and R fused and thickened, but separating again after the pterostigmal area. Apical cell 5 very shortly stalked. The three cross-veins of the anastomosis step-like, about equidistant one from another. Thyridial cell slightly longer than discoidal cell.

Genitalia ♂, 9th tergite in lateral view broadly rounded; preanal appendages apparently absent; penis stout, curved downwards; clasper slender, acute.

Fore-wing 6·5–7 mm.

(In alc.) head and thorax brown. Fore-wing membrane dark brown with darker circular spots, each circumscribed by a pale hyaline ring, situated at junctions of the veins, on the veins of the anastomosis, and at apices of veins at wing-tip.

Locality.—Chemba, Zambesi, Portuguese East Africa (Mosely).

Distribution.—Sudan (Ulmer).

Potamoryza n. g.

Imago.—Tibial spurs 0, 2, 2. In fore-wing Sc and R contiguous at base, and united distally by a thick and very oblique cross-vein, Sc continued as a very fine vein to margin. No cross-vein between R and Rs. Fork 1 acute. Otherwise as in *Oecetis*.

Larva.—As in *Oecetis*.

Pupa.—As in *Oecetis*, but gills absent.

Remarks.—Resembles *Oecetinella* Ulmer, but the cross-vein between M and Cu is proximal to the cross-vein between Rs and M, and the fusion of Sc and R is not so complete.

Potamoryza modesta n. sp.

(Fig. 33.)

Imago.—In fore-wing portions of M and 1A semi-hyaline. In hind-wing a false vein or fold along upper side of Cu_1–Cu_{1a}. Maxillary palp very long, densely clothed with outstanding thickened setae, 1st joint shortest, 2nd longer, 3rd twice 1st, 4th $\frac{2}{3}$ length of 3rd, 5th subequal to 3rd. Labial palp $\frac{1}{4}$ length of maxillary palp, 1st and 2nd joints subequal, 3rd equal to 1st and 2nd together.

Genitalia ♂, preanal appendages pear-shaped (in dorsal view), rather close together and situated high up, with a slender median process arising just below them, bearing a few spinules; 10th tergite deeply bifid, the apices acute and curving downwards; penis simple, in lateral view rather abruptly narrowed in distal half, no titillators; clasper elongate, slender, with basal inwardly curving expansion, apex acute, incurved. ♀ with apical flaps large, ovate.

Fore-wing 5·5–6 mm.

Head and thorax greyish-fawn with paler fawn hairs. Palps and antennae greyish, the latter not annulate. Fore-wing greyish-fawn, hind-wing grey, with blackish fringe on hind margin. Abdomen pale emerald green. Eighth sternite in ♀ blackish.

Larva.—Head and pronotum corneous, the latter with medio-dorsal longitudinal division. Mesonotum with a pair of oblong plates, each with a minute plate in front. Eyes large. A single presegmental dorso-lateral and ventro-lateral gill on each of segments 2 and 3.

Head amber, eyes black. Pronotum and the mesonotal plates pale amber. Legs amber, mid and hind legs with black marks as in fig. 33 *k*. Abdomen pale emerald green.

5 mm.

Case tubular, slightly curved, composed of sand-grains. 5–6 mm.

Pupa.—Labrum with slight median projection. Mid tarsus fringed. Presegmental dorsal plates on segments 3–7, each with six spines arranged in a crescent; postsegmental plate on segment 5 narrow, transversely elongate, with several spines. No gills. Anal appendages with conical projection on middle of inner margin, bearing several stout spines, apex acute, incurved.

5 mm. Abdomen pale green.

Case the same as that of larva, a semi-circular area at lower anterior end, where it is adnate to the rock, membranous and without sand-grains, front and hind ends closed by membrane, the former with subcircular central aperture, the latter with oval aperture near dorsal margin.

Localities.—Table Mt. (Orange Kloof) (K. H. B., March 1933); Jonkershoek, Stellenbosch (K. H. B. and H. G. W., February 1931 and February 1933); Groot Drakenstein (A. C. H., April 1932, empty cases, and February 1933); Naudesberg, Worcester (K. H. B., August 1932, empty cases).

Remarks.—This is a very common species in the Stellenbosch-Drakenstein districts, the cases being found in numbers on the under-surfaces of stones and boulders. The imagos, however, are very shy and retiring, and appear to be out only in February, March, and April. The pupal cases usually occur in little groups of 3–6 close together.

The moulted larval skin seems to be pushed out through the aperture at the hind end by the pupa, as none of the cases which were opened contained any parts of the larval skin as is usual in pupal Caddis-cases (*cf.* Sibley, Lloyd Libr. Bull. 27, Entom., Ser. 5, 1926, p. 212, *Molanna*). Moreover, the tips of the anal appendages of the pupa may frequently be seen projecting through the aperture.

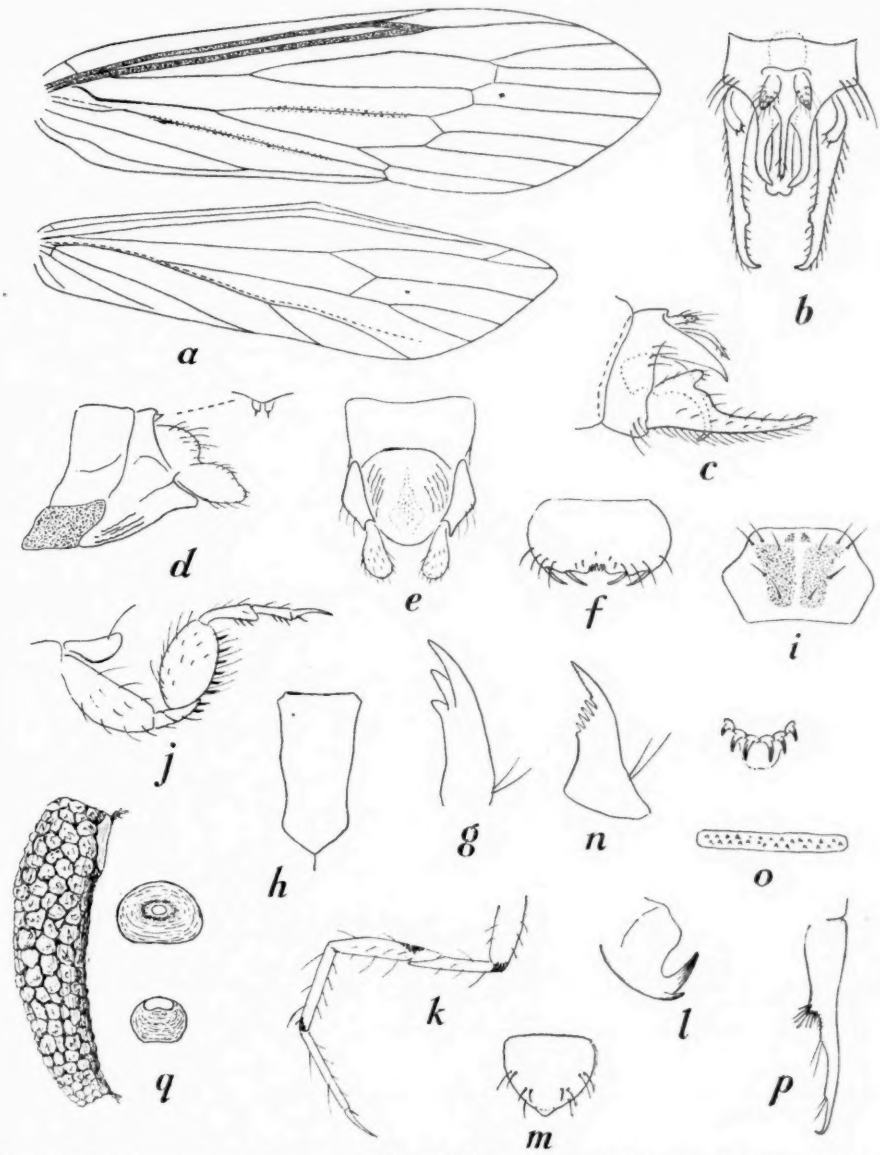

FIG. 33.—*Potamoryza modesta* n. g., n. sp. *a*, fore- and hind-wings; *b*, *c*, dorsal and lateral views ♂ genitalia; *d*, *e*, lateral and ventral views ♀ genitalia, with dorsal tubercles in dorsal view; *f*, *g*, *h*, labrum, mandible, and clypeus of larva; *i*, mesonotum of larva; *j*, *k*, fore and mid legs of larva; *l*, anal claw of larva; *m*, *n*, labrum and mandible of pupa; *o*, dorsal plates of 5th segment of pupa; *p*, anal appendage of pupa; *q*, pupal case, with membranes from front and hind ends. (In fore-wing Sc and R are purposely represented as unduly thickened, in comparison with the other veins.)

Gen. *Homilia* McLach.

Ulmer, 1907, p. 138. Navas, 1930, p. 417; 1931, p. 278; 1931, p. 141.

Imago.—Tibial spurs 1, 2, 2. In fore-wing upper margin of discoidal cell curved. Anastomosis step-like. Hind-wing broader than fore-wing. Apical forks 1, 5 (♂, ♀) in both wings, fork 1 and apical cell 4 stalked in both wings. Cu_1 forked in hind-wing.

Genitalia ♂ complicated (*cf.* Ulmer, 1909, p. 94, fig. 154), 9th tergite typically divided into two short lobes, 10th tergite lanceolate, with a slender appendage on either side; preanal appendages very long, slender; claspers deeply excised apically, with a slender internal appendage.

Remarks.—Differs from *Leptocerus* only in the tibial formula and the similarity of the venation in the two sexes (apical fork 3 being absent in ♀), and in the greater complexity of the ♂ genitalia.

The character of the tibial spurs may not prove altogether satisfactory. In one of the specimens described below the left fore tibia bore two distinct and equal-sized spurs, while the right bore only one. The other specimens had unfortunately lost the fore legs.

As the ♂ genitalia are closely similar to those of the European *leucophaea*, and the venation of the two sexes do not differ, these specimens are referred to *Homilia*.

In addition to one European species, three species have been described from the Belgian Congo: *pallida* Navas, 1930; *vestita* Navas, 1931; and *aurifera* Navas, 1931.

Homilia vetulata n. sp.

(Fig. 34.)

Imago.—In fore-wing thyridial cell shorter than discoidal cell, but venation otherwise like that of *leucophaea*, apical forks 1, 5, in both sexes. In hind-wing fork 5 very broadly lenticular.

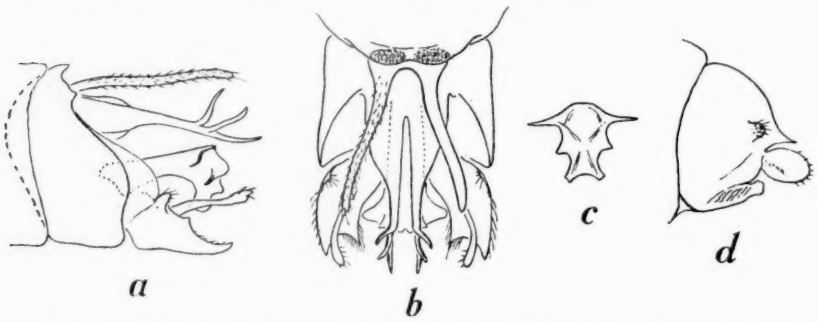

FIG. 34.—*Homilia vetulata* n. sp. *a*, *b*, lateral and dorsal views ♂ genitalia; *c*, posterior view of apex of penis; *d*, lateral view ♀ genitalia.

Genitalia ♂, 9th tergite very slightly arcuate on hind margin, with two transverse oval patches of minute spinules; preanal appendages elongate, slender, setose; 10th tergite deeply cleft, each lobe narrowing distally to an acute point, and bearing two divergent upstanding processes; no lateral appendages; penis short and stout, upper margin in lateral view straight, apex with lateral flanges and recurved spiniform processes; clasper triangular in side view, apex acute, a slender club-shaped process on inner surface.

Fore-wing 6·5 mm.

Head and thorax fuscous with white and greyish-white hairs. Wings sepia-brown with white hairs forming a speckling of small white dots and irregular marks. Legs grey, tarsi annulate. Antennae grey, annulated with white.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, 2 ♂♂, 2 ♀♀).

Gen. *Setodes* Rambur.

Ulmer, 1907, p. 145; 1912, p. 111; 1931, p. 25. Lestage, 1919A, p. 319; 1921, p. 650 (larva and pupa). Mosely, 1931, p. 549.

Imago.—Tibial spurs 0, 2, 2. Wings narrow, lanceolate, apically more or less pointed. In fore-wing discoidal cell usually not very long, thyridial cell very long, apical forks 1, 5 (♂, ♀), fork 1 stalked, apical cell 4 stalked or sessile, anastomosis oblique, M forked. Hind-wing very narrow, apical forks 1, 5, M forked, often an indication of an accessory vein (groove or fold) above Cu_1.

Larva.—Head oval. Mandible chisel-like. Hind leg longest, with or without fringes. Mid claws often bifid. Hind tibia of a single piece. Lateral line absent. Gills minute.

Case straight, narrow, formed of secreted silk, or sand-grains.

Pupa.—Tibial spurs 0, 2, 2. Labrum variable. Presegmental dorsal plates on segments 3–6. Gills absent.

Case the same as that of the larva.

Remarks.—The genus is widely distributed, but only four species are known from Africa: *hargreavesi* Ulmer and *sierraleonana* Ulmer, both from Sierra Leone; *gracilis* Ulmer from Lake Chad, Cameroons, and Mozambique; and *squamosa* Mosely from Natal.

McLachlan divided the genus into two according to the character of the 4th apical cell (stalked or sessile), and the presence or absence respectively of an accessory groove-like vein in the hind-wing. The group with the additional vein (*tineiformis*, etc.) seems to be further characterised by larvae with fringed hind legs and a case composed entirely of secreted silk (Ulmer, 1912, p. 123).

Key to the South African species.

1. In fore-wing apical cell 4 stalked. In hind-wing no accessory vein . . . . *squamosa.*
2. In fore-wing apical cell 4 sessile. In hind-wing an accessory vein present.
   a. In fore-wing discoidal cell shorter than its stalk. Anastomosis moderately oblique . . *gracilis.*
   b. In fore-wing discoidal cell longer than its stalk. Anastomosis very oblique . *didymata.*

Setodes squamosa Mosely.

Mosely, 1931, p. 549, figs. 16–21.

Imago.—In fore-wing stalk of discoidal cell nearly twice as long as cell, stalk of fork 1 shorter than fork, apical cell 4 stalked, anastomosis zigzag, 3rd cross-vein being distal to 2nd. In hind-wing fork 1 very short, M forked only near margin, far distal to cross-vein between Rs and M, no accessory vein above Cu_1, Rs incomplete proximally.

Genitalia ♂, preanal appendages short, blunt, each with a dorsal knob; 10th tergite divided into two spiniform processes, from each of which arises a longer spiniform process; penis simple, strongly curved downwards; claspers united at base, with a short basal, upturned branch and a longer, slender, lateral branch. ♀, a dorsal quadrangular process ending in a forked process, below which are two flaps.

Fore-wing ♂ 6·5 mm., ♀ 5·5 mm.

Head whitish with white hairs. Legs, palpi, and antennae ochraceous. Fore-wing with yellowish-green hairs, hind margin with a white band, in which are 8–9 chocolate spots, apical third of wing with a broad U-shaped chocolate mark, and some isolated dark spots in the apical cells.

Locality.—Weenen, Natal (Mosely).

Setodes gracilis Ulmer.

Ulmer, 1912, p. 111, figs. 39–41, and p. 123 (larva); Lestage, 1919A, p. 319.

Imago.—In fore-wing discoidal cell shorter than its stalk, stalk of fork 1 very short, apical cell 4 sessile, anastomosis moderately oblique. In hind-wing fork 1 longer than its stalk, Rs complete, cross-vein between Rs and M distal to fork of latter, an accessory vein above Cu_1.

Genitalia ♂, preanal appendages short, each bearing a long, slender filament; 10th tergite consisting of two strong, downwardly curved, acute processes; clasper strong, convex above, somewhat volute, bearing spines on its inner margin.

Fore-wing 5–6 mm.

Head and thorax with black hairs, a tuft of white hairs in front of each eye. Antennae blackish, annulated with white. Legs pale brown with silvery tinge. Fore-wing with blackish hairs and scattered white or silvery hairs, two silvery white spots on costal margin, the distal one more sharply defined and extending to the wing-spot.

Larva.—Similar to those of *tineiformis* and *interrupta* (Ulmer, 1912, p. 123).

Locality.—Andrada, N.W. of Beira, Portuguese East Africa (Ulmer).

Distribution.—Lake Chad, Cameroons, Ruanda (larva), (Ulmer).

Setodes didymata n. sp.

(Fig. 35 *a–g.*)

Imago.—In fore-wing discoidal cell longer than its stalk, fork 1 about as long as its stalk, apical cell 4 sessile, anastomosis very oblique. In hind-wing fork 1 slightly shorter than its stalk, Rs complete, cross-vein from Rs to M distal to fork of latter, an accessory vein above Cu_1.

Genitalia ♂, 9th tergite a short transverse plate; preanal appendages slender, elongate, each tipped with two setae; 10th tergite consisting of two slender processes; penis stout at base, nearly straight in side view; claspers basally contiguous, each consisting of a dorsally convex, somewhat volute process, bearing spines on inner surface, and long hairs on outer surface of basal portion.

Fore-wing 4·5 mm. Antennae *ca.* 12 mm. Maxillary palp 2 mm.

Head and thorax dark umber-brown, with white hairs. Maxillary palp brown with white hairs. Antennae greyish-brown, narrowly annulate. Legs pale ochraceous or whitish. Wing membrane pale brown. Fore-wing dark sepia-brown, with a conspicuous silvery-white triangular patch from costa to middle of discoidal cell, and one or two smaller, less conspicuous, and less regular, patches midway between the large patch and base of wing (fig. 35 *a*). Fringe on hind margin of hind-wing dark sepia.

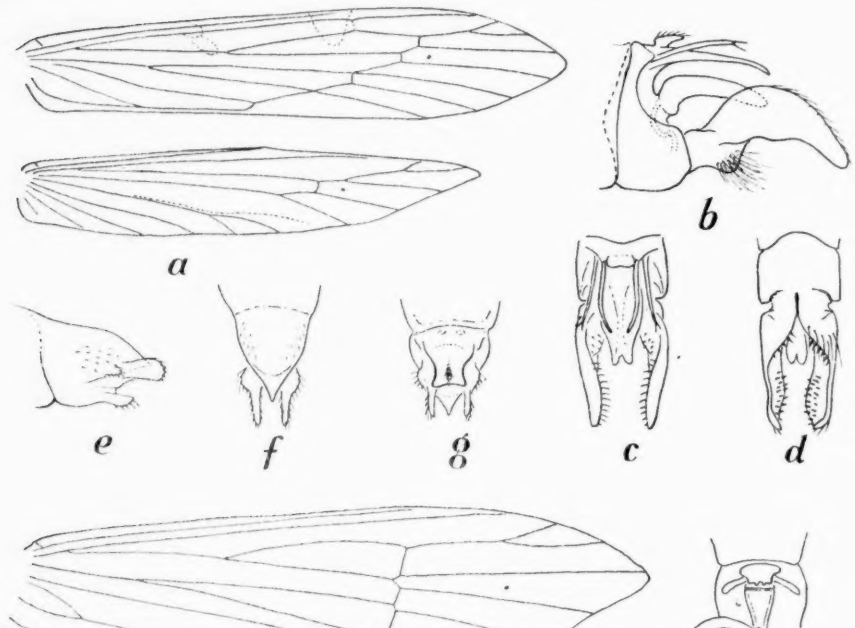

FIG. 35.—*Setodes didymata* n. sp. *a*, fore- and hind-wings; *b*, *c*, *d*, lateral, dorsal, and ventral views ♂ genitalia; *e*, *f*, *g*, lateral, dorsal, and ventral views ♀ genitalia. *Adicella sicula* n. sp. *h*, fore- and hind-wings; *i*, *j*, lateral and dorsal views ♂ genitalia (process at base of penis on right side only); *k*, *l*, lateral and ventral views ♀ genitalia.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, ♂♂ and ♀♀).

Remarks.—This species is in general coloration and ♂ genitalia very similar to *gracilis*, but differs in several points of detail.

Gen. *Adicella* McLach.

Ulmer, 1907, p. 141; 1930, p. 493. Lestage, 1919A, p. 320; 1921, p. 634 (larva and pupa).

Imago.—Tibial spurs 1, 2, 2. Wings moderately narrow. In fore-wing no cross-vein between R and discoidal cell, which is rather broad; thyridial cell long, apical forks 1, 5 (♂, ♀), fork 1 stalked, anastomosis nearly straight and transverse. Hind-wing narrower than fore-wing, with only apical fork 1, Cu_1 not forked.

Genitalia ♂, preanal appendages short; 10th tergite bifid or entire; claspers biramous.

Larva.—Head oval. Antennae long, with apical seta. Mandibles chisel-like, asymmetrical. Hind leg longest, without fringes. Hind tibia of one piece. Lateral tubercles of 1st abdominal segment with long chitinous prolongation. Lateral line obsolete or almost so (minute points on segment 8). Gills very feeble.

Case cylindrical, curved, composed of sand-grains or mineral particles.

Pupa.—Tibial spurs 1, 2, 2. Labrum longer than broad, ovate-lanceolate. Presegmental dorsal plates on segments 3–7. Gills?.

Remarks.—The genus is found in Europe, East Indies, and Africa. The widely distributed *A. syriaca* Ulmer has been recorded from Syria, Kilimanjaro, Caucasus, and Ceylon. *A. triaenodiformis* Ulmer is from Abyssinia.

Adicella sicula n. sp.

(Fig. 35 *h–l.*)

Imago.—Venation very like that of *triaenodiformis*, but stalk of fork 1 slightly longer.

Genitalia ♂, 9th tergite transverse, with two small projections; preanal appendages short, rod-like, setose; 10th tergite a narrow triangular plate, bearing at its apex a long movable semi-circularly curved process, which is apically serrate on its lower margin; penis stout, strongly curved, with a chitinised spiniform process at base (on right side only in the single specimen); clasper biramous, the upper branch apically furcate, the lower branch apically excised on upper margin.

Fore-wing 7 mm.

Head and thorax pale ochraceous, with whitish hairs. Antennae ochraceous, with narrow dark annulations. Wings pale ochraceous.

Locality.—Otjimbombe, Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, ♂, ♀).

Remarks.—Beside the similarity of the venation to that of the Abyssinian species there is a most remarkable likeness in the ♂ genitalia to those of *Triaenodes serrata* Ulmer (1912, p. 110, fig. 38). The preanal appendages in *A. sicula* are much shorter, but the penis and claspers in lateral view are very similar. So is the 10th tergite with its large curved serrate process; but whereas here the tergite is entire and the process single, in *T. serrata* the tergite is bifid and each lobe bears a process.

Family Hydropsychidae.

Ulmer, 1907, p. 153; 1912, p. 119 (larvae). Lestage, 1919A, p. 286; 1921, p. 531 (larvae and pupae).

Imago.—Tibial spurs various, but fore tibia with never more than two spurs. Mid leg ♀ often expanded. Antennae as long as, or much longer than, fore-wing. Maxillary palp 5-jointed ♂, ♀. Last joint of both maxillary and labial palps segmented. Maxillary and labial palps sometimes rudimentary or absent. Ocelli absent. Neuration variable. In fore-wing fork 1 always present, stalked.

Genitalia ♂, preanal appendages absent (one exception); 10th tergite lamellate; penis without titillators; claspers slender, 2-jointed. ♀ without ovipositor.

Egg-mass cemented to objects under water (Ulmer, 1909A, p. 205).

Larva.—Campodeiform. Head relatively small. Antennae rudimentary. Labrum with lateral brush of long setae. Mandibles stout, with (usually) internal tuft in left. Maxillary palp 5-jointed. Labial palp 2-jointed. Pro-, meso-, and metanotum corneous. Prosternal spine absent. Legs short, stout, hind leg slightly longer than mid leg. Plaque d'appui furcate (usually). Abdominal segments well demarcated. No lateral line. Small delicate lateral processes (? branchial) on segments 3–7. Gills well developed, in tufts, on sternites of meso- and metanotum and abdominal segments 3–6 or 7. 4–5 anal gills. Anal appendages long, 2-jointed, terminating in a simple curved claw.

No definite case, the larva living in a more or less open network of silken threads.

Pupa.—Fusiform. Antennae as long as body (longer in the *Macronematinae*, ? no pupa known). Labrum semi-circular, trilobed, median lobe much larger than lateral ones. Mandibles long, asymmetrical, dentate or serrulate. Tibial spurs various. Mid leg fringed. Presegmental dorsal plates on segments 3–8, postsegmental plates on segments 3 and 4. No lateral line. Lateral processes on segments 3–7 or 8 as in larva, but much larger. Gills as in larva, but absent from thoracic sternites, and 1st abdominal segment, and sometimes also from 7th segment. Anal appendages rod-like, elongate, apically truncate or bifid.

Case oval, composed of sand-grains cemented to stones.

Remarks.—This family, which contains some of the largest Caddis-flies, is divided into two groups, the *Hydropsychinae* with short antennae, and the *Macronematinae* with long antennae. The larval and pupal stages appear to be very inadequately known, especially in the *Macronematinae*, which do not occur in Europe.

The abdomens of all the representatives should be more closely studied, if possible on material in alcohol or formalin.

In Ulmer's Monograph it is stated that a filiform appendage occurs on the 4th or 5th abdominal segment in certain genera of the *Hydropsychinae*, but that such processes are absent in the *Macronematinae*, except for the short oval flaps in one genus of the latter subfamily. As shown below, this is too sweeping a generalisation. Filamentous appendages occur in *Macronema capense* and *natalense* (fig. 42 *b*), and short pedicillate knobs in *Protomacronema pubescens* (fig. 41 *d*, *e*).

Furthermore, there are structures which have not hitherto been described, though on enquiring of Mr. Mosely whether they were present in the typical species of *Hydropsychodes*, he informed me that he had already observed them in some species. These structures are tuft-like or fan-like bunches of filaments arising laterally from the articular membrane between the segments, occurring on the hind margins of segments 2–7 in both sexes (figs. 36 *c*, 37 *c*, 39 *e*, *f*, 41 *i*). In dry specimens they curl up and usually appear as dark dots, and may possibly have been regarded merely as pigment spots. They are not tracheal. I have found them in *Hydropsyche ulmeri*, all the species of *Hydropsychodes* mentioned below (I have not seen *H. lesnei*), both species of *Sciadorus* and *Leptonema occidentale*. They probably occur in other species and genera.

In the last-mentioned species there is a pair of oblique narrow-oval bare patches on the sternite of 5th abdominal segment (♂). The rim surrounding each patch is more strongly chitinised on the outer side, and is here raised into a slight ridge; anteriorly this chitinous framework connects with the transverse bar on the anterior margin of the segment (fig. 41 *i*).

The most remarkable abdominal structures are the internal vesicles which have been found in the ♂ of *Diplectrona* (Eltringham, Trans. Ent. Soc. Lond., vol. lxxix, 3, p. 539, 1931), and *Smicridea* (Mosely in litt. 7/6/32).

Eltringham believed that these vesicles were tracheal in function, and gave a photographic reproduction of one of his sections in proof thereof. To my mind his figure is very inconclusive. It shows a cross-section of a tracheal tube in *apposition* to a vesicle, but not an actual connection between the two. In the specimens of *Sciadorus* which I have examined I am convinced that there is no connection; by dissection the tracheae can be pealed off the vesicles without hindrance, and in a series of both longitudinal and transverse sections there is no trace of any tracheal connection.

These vesicles, of which there are two pairs in both species of *Sciadorus*, occupying segments 5–7, open ventro-laterally on the hind margins of segments 6 and 7; more exactly on the infolded articular membrane, just internal to the tuft-like filaments, between segments 6 and 7, and 7 and 8 respectively (fig. 39 *e*). Their walls are thick, bounded externally by a thin (apparently chitinous, not dissolved in KOH) cuticle, and composed of long prismatic cells arranged radially, and producing in surface view a honeycomb appearance (fig. 39 *g*, *h*, *i*). The nuclei lie at the internal ends of the cells. The vesicles are not hollow, but more or less filled with a spongy tissue with numerous lacunae. This tissue often arises in strands from the inner ends of the cells, and gives the impression that it might be a mucous secretion.

It seems clear that these vesicles have some sexual significance, and if by great good fortune a pair *in copula* were captured, the answer to the puzzle might be found.

Key to the Subfamilies.

1. Antennae as long as fore-wing. Maxillary and labial palps present. Fore-wing always with closed discoidal cell . . . . . *Hydropsychinae.*
2. Antennae much longer than fore-wing. Maxillary and labial palps sometimes absent. Discoidal cell in fore-wing often open or absent. In hind-wing a subdiscoidal cell, or the discoidal cell is open. *Macronematinae.*

Subfamily HYDROPSYCHINAE.

Imago.—Tibial spurs (in African genera) 2, 4, 4. Mid leg ♀ often expanded. Claws of ♂ sometimes abnormal. Antennae about as long as fore-wing. Maxillary and labial palps always present. Fore-wing with discoidal cell closed, median and thyridial cells present (one exception), sometimes an additional costal cross-vein. Hind-wing with discoidal cell usually closed, median cell often closed; M forked proximal to anastomosis, fork 1 present or absent, forks 2, 3, 5 present.

*Key to African genera.**

1. Hind-wing with fork 1 present . . . . . *Hydropsyche.*
2. Hind-wing with fork 1 absent.
   a. No lateral abdominal processes, nor internal vesicles. Sc and R in hind-wing often fused distally. *Hydropsychodes.*
   b. Lateral processes on 5th abdominal segment, and two pairs of internal vesicles. Sc and R in hind-wing separate throughout . . . . . *Sciadorus.*

* As Ulmer (1930, p. 488; 1931, p. 3) transfers *Symphitopsyche plutonis* Banks to *Hydropsychodes*, the former genus remains confined to Mauritius.

Gen. *Hydropsyche* Pictet.

Ulmer, 1907, p. 169; 1908, p. 9; 1912, p. 122 (larva). Banks, 1920, p. 357. Navas, 1926, p. 109. Lestage, 1919A, p. 287; 1921, p. 535 (larva and pupa).

Imago.—Outer claws of legs of ♂ replaced by a tuft of black bristles (Ulmer). Mid leg ♀ expanded. Maxillary palp 1st joint very short, 2nd long, 3rd and 4th subequal but shorter than 2nd, expanded, 5th as long as the others together. Labial palp 1st and 2nd joints short, 3rd long. Fore-wing discoidal cell short, median cell long, thyridial cell very long. Forks 1, 2, 3, 4, 5, of which 1, 3, 5 stalked. Hind-wing discoidal cell short, closed, median cell usually closed. Forks 1, 2, 3, 5, fork 1 very short, 1 and 3 stalked. Sc and R separate to margin, but joined by a cross-vein near end, similarly R and R_{2+3}. No lateral filamentous processes on abdomen. No internal vesicles. Penis rather elongate, apex bifid.

Larva.—Abdominal segments gradually decreasing in width posteriorly. Anal gills 4.

Pupa.—Anal appendages obtuse, truncate, or feebly bifid apically.

Remarks.—The genus is widely distributed, but only three species have been known from Africa: *propinqua* Ulmer from Cameroon, Togo, Tanganyika; *fasciolata* Navas from Congo; *longipalpis* Banks from Madagascar. Ulmer mentions larvae from Ruanda similar to those of the European species. The species described below conflicts in certain respects with the above diagnosis, and quite possibly it should be placed in a new genus.

Hydropsyche ulmeri n. sp.

(Fig. 36.)

Ulmer, 1913, p. 191 (*propinqua*, non Ulmer, 1907); Lestage, 1919A, p. 287 (part).

Imago.—Both tarsal claws present in ♂, the outer concealed by a brush of black hairs. Fore-wing with discoidal and median cells as broad as long, both longer than in *pellucidula* (Ulmer, 1907, pl. xxiii, fig. 210); fork 5 beginning distinctly proximal to end of median cell and slightly proximal to line joining base of fork 4 and point where $Cu_2 + 1A$ join hind margin. In hind-wing Sc and R fused distal to cross-vein, uniting R with R_{2+3}, which is slightly proximal to end of discoidal cell; lower branch of fork 1 (R_3) shorter than its stalk, upper branch (R_2) very short; median cell closed, its cross-vein very slightly proximal to cross-vein from R_{4+5} to M_{1+2}; M and Cu_1 very close together, thyridial cell thus extremely narrow.

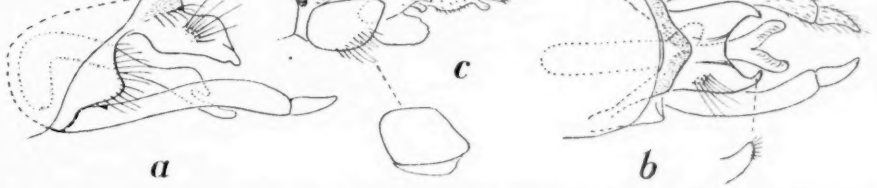

FIG. 36.—*Hydropsyche ulmeri* n. sp. *a*, *b*, lateral and dorsal views ♂ genitalia; *c*, lateral view ♀ genitalia, with one of the subgenital plates in ventral view.

Genitalia ♂, 9th tergite in dorsal view with median rounded-triangular projection, 10th tergite bilobed, the median portion less strongly chitinised than the lateral portions, the apex of each of which is conical, near the base a low boss with long setae each arising from a tubercle; penis with bilobed expansion at about ⅔ its length as well as apically bifurcate; clasper slender. ♀ terminal tergite rounded, two ventro-lateral flaps with three digitiform processes, at base of which a small chitinous knob; subanal plates subquadrangular.

Ventro-lateral tuft-like bunches of filaments on segments 2–7 in both sexes.

Fore-wing 10–11 mm.

Head and thorax castaneous with golden hairs. Wing membranes buff, neuration slightly darker; fore-wing with pale golden-brown and buff hairs, in unworn specimens forming a dotted or flecked pattern, especially towards the apex; hind-wing with some long darker hairs along proximal half of M, marginal fringe pale buff. Legs and antennae ochraceous, the latter with narrow and obscure dark annulations.

Localities.—M'fongosi, Zululand (Ulmer); Acornhoek, Transvaal (R. W. E. Tucker, November 1918); Smithfield, O.F.S. (S.A. Mus., September 1910).

Remarks.—I have examined the alleged ♂ with mutilated abdomen recorded by Ulmer in 1913 and returned to the South African Museum bearing his MS. identification. The specimen is really a ♀ with shrunken abdomen. There are other specimens in the collection from the same locality (W. E. Jones, September 1911 and January 1914).

From the above description it will be seen that these specimens do not agree with *H. propinqua* in the ♂ genitalia. Sc and R are fused (as in *Symphitopsyche*). The claws of the ♂ do not conform with the generic

diagnosis; in view of this the typical species of *Hydropsyche* might perhaps be re-examined to see if the outer claw is really replaced, or merely concealed, by a tuft of hairs. Further, there are the peculiar tufts of filaments on the abdomen of both sexes, such as are found in *Hydropsychodes* (*infra*), which have not yet been recorded in *Hydropsyche*, though in this respect also fresh alcoholic material of typical species might disclose their presence. For the present the species is retained in *Hydropsyche*.

Gen. *Hydropsychodes* Ulmer.

Ulmer, 1907, p. 174; 1912, p. 93; 1930, pp. 482 *sqq.* and p. 501 (larva); 1931, pp. 1 and 16 *sqq.* Navas, 1927, p. 212; 1931A, p. 138. Lestage, 1919A, p. 288. Banks, 1920, p. 357.

Imago.—Like *Hydropsyche* but claws normal in both sexes, in hind-wing median cell open, fork 1 absent, forks 3 and 5 stalked, the latter very shortly so or even sessile. Sc and R either separate and without connecting cross-vein, or fused distally. No filamentous processes on abdomen, and no internal vesicles. A series of lateral tuft-like filaments on segments 2–7. Penis moderately long, apex bifid.

Larva and pupa not hitherto described with any certainty (*cf.* Ulmer, 1930, p. 501). Those described below resemble those of *Hydropsyche* in general. Larva with four anal gills. Pupa with lateral finger-like processes on segments 3–7. Anal appendages feebly excised apically.

Remarks.—In all the species of which the venation has been figured Sc and R in hind-wing are separate throughout their length, except *sexfasciata* (see Ulmer, 1912, fig. 18), and four Abyssinian species (Ulmer, 1930). In *sexfasciata* these two veins are fused slightly proximal to the cross-vein connecting them to R_2. In the Abyssinian species, as in *Symphitopsyche*, and the species described below (except *lesnei*), Sc and R are fused distally to the connecting cross-vein.

The South African specimens identified by Ulmer in 1913 as *H. diminuta* prove to have Sc and R fused, and thus do not resemble Ulmer's figure of Walker's species. Ulmer (1931, p. 16) is of opinion that several species have been united under *diminuta*.

The genus contains twelve African species in addition to the two described by Ulmer from Natal, and one from Zambesi described by Mosely.

I have seen two specimens from the Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923), but both are ♀♀ and hence regarded as unidentifiable.

Key to the South African species.

1. Sc and R in hind-wing fused distally.
   - *a.* 10th tergite ♂ with relatively wide quadrangular excision, a median lobe obsolete or very feebly developed.
     - i. 9th tergite transverse, apically convex . . . . . *thomasseti.*
     - ii. 9th tergite transverse, apically trilobed . . . . . *zuluensis.*
   - *b.* 10th tergite triangular or trilobed, the median lobe prominent . . . *triangularis.*
   - *c.* 10th tergite with narrow subtriangular or semi-circular excision . . . *lateralis.*
2. Sc and R in hind-wing separate throughout . . . . . *lesnei.*

Hydropsychodes thomasseti Ulmer.

(Fig. 37 *g.*)

Ulmer, 1931, p. 18, figs. 16, 17.

Imago.—In hind-wing Sc and R fused.

Genitalia ♂, 9th tergite with distal margin gently convex, 10th tergite trilobed, the lateral lobes longer (slightly or considerably) than the median triangular point, apically blunt; penis apically bifurcate. ♀ similar to that of *lateralis*.

Lateral tuft-like appendages on abdominal segments 2–7.

Fore-wing 6–6·5 mm.

Head and thorax blackish with golden hairs. Fore-wing golden-yellow flecked or speckled with paler, marginal fringes grey-brown.

Locality.—Weenen, Natal (Ulmer), January, February, March, April, August, October, November, December.

Remarks.—Ulmer says "neuration as before," *i.e.* corresponding with fig. 13 of *diminuta*, which shows Sc and R separate. In four examples (1 ♂ *thomasseti*, 3 ♀♀) from the British Museum, however, these veins are fused.

Hydropsychodes zuluensis n. sp.

(Fig. 37 *h–j.*)

Ulmer 1913, p. 191 (*diminuta* non Wlkr., part).

Imago.—Venation as in *lateralis*. In hind-wing Sc and R fused distally.

Genitalia ♂, 9th tergite with distal margin trilobed, the lateral points slightly longer than the median one, 10th tergite quadrangular with a lateral setose boss on each side, distal margin straight between the lateral, apically blunt processes; penis apically bifurcate. ♀ similar to that of *lateralis*.

Lateral tuft-like appendages on abdominal segments 2–7.

Fore-wing 6–8 mm.

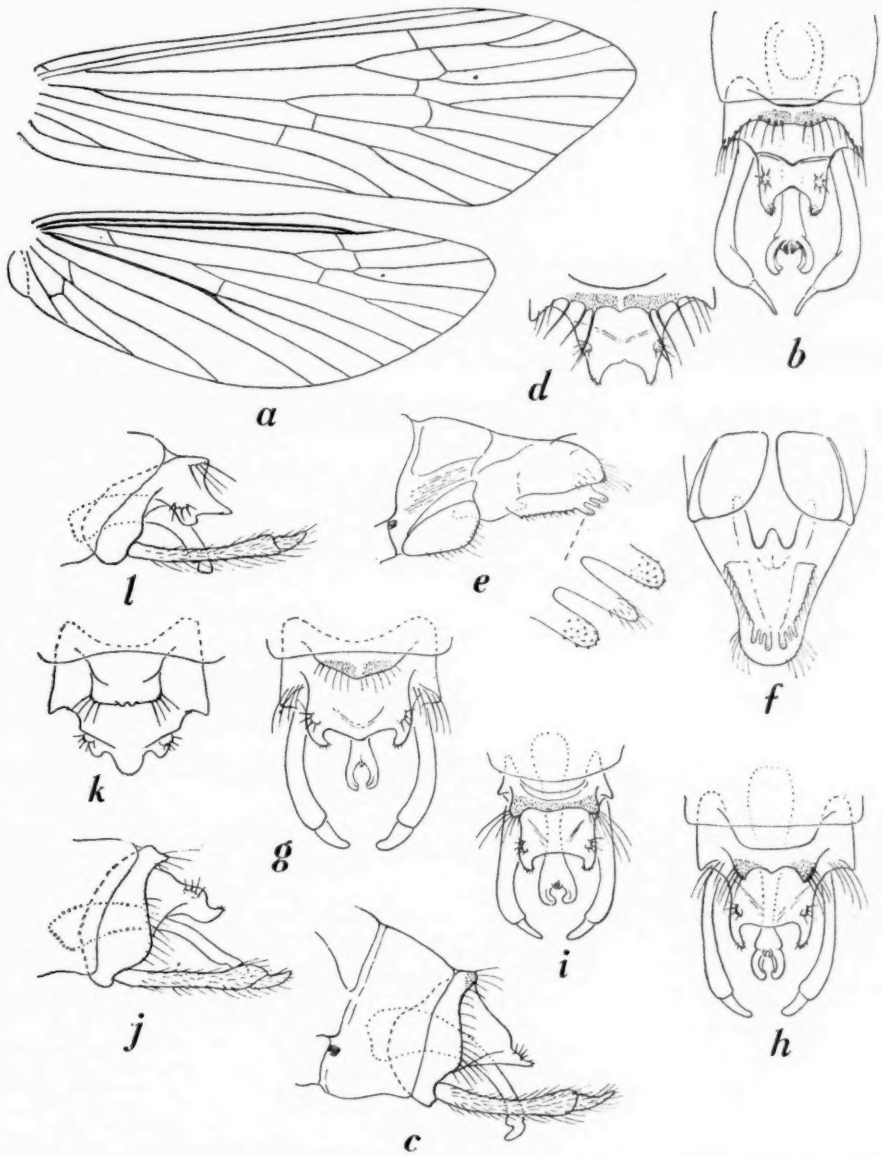

FIG. 37.—*Hydropsychodes lateralis* n. sp. *a*, fore- and hind-wings; *b*, *c*, dorsal and lateral views ♂ genitalia (Groot Drakenstein); *d*, 9th and 10th tergites of specimen from Ceres; *e*, *f*, lateral and ventral views ♀ genitalia, with digitiform processes of the ventral flaps further enlarged. *H. thomasseti* Ulmer. *g*, dorsal view ♂ genitalia (paratype ex-Brit. Mus.). *H. zuluensis* n. sp. *h*, dorsal view ♂ genitalia (Zululand); *i*, *j*, dorsal and lateral views ♂ genitalia of specimen from Smithfield, O.F.S. *H. triangularis* Ulmer. *k*, *l*, dorsal and lateral views ♂ genitalia, specimen from Louis Trichardt.

Head and thorax castaneous with pale golden hairs. Fore-wing golden-brown dotted and speckled with paler. Legs and antennae ochraceous or fulvous, the latter obscurely annulate.

Localities.—M'fongosi, Zululand (W. E. Jones, October and February); Acornhoek, Transvaal (R. W. E. Tucker, November 1918, ♂); Smithfield, O.F.S. (S.A. Mus., ♂).

Remarks.—Very like *thomasseti* and possibly only a variety. The margin of the 9th tergite is the main difference.

Some larvae from Natal (L. A. Day) resemble those of *lateralis*, described below.

Hydropsychodes triangularis Ulmer.

(Fig. 37 *k*, *l*.)

Ulmer, 1931, p. 19, figs. 18, 19.

Imago.—In hind-wing Sc and R fused.

Genitalia ♂, 9th tergite quadrangular, distal margin with minute median notch, and 3–4 long setae on outer distal angles; 10th tergite subtriangular, trilobed, the median lobe larger and projecting much farther than the lateral lobes; penis apically bifurcate.

Fore-wing 6–6·5 mm. (Ulmer); 7 mm. (Louis Trichardt).

Head and thorax fulvous. Legs and antennae ochraceous. Wings pale brown, with pale golden pubescence, faintly chequered distally (the specimen may be faded).

Localities.—Weenen, Natal (Ulmer); Louis Trichardt, Transvaal (R. F. Lawrence, January-February 1928).

Remarks.—I have seen only the one ♂ from Louis Trichardt, which is here described and figured, and which seems to belong to Ulmer's species. (Two specimens received from the British Museum as *triangularis* are both ♀♀, and therefore unidentifiable, as Ulmer says, *loc. cit.*, p. 20.)

Hydropsychodes lateralis n. sp.

(Figs. 37 *a–f*, 38.)

Ulmer, 1913, p. 191 (*diminuta*, non Wlkr., part).

Imago.—In fore-wing cross-vein between Sc and R often indistinct or obsolete, distal margin of median cell also sometimes faint; position of cross-vein R_1 to R_{2+3}, distal margin of discoidal cell, and cross-vein R_{4+5} to M varying slightly; Cu_1–Cu_1b distinctly thicker than neighbouring veins. In hind-wing Sc and R distally fused; cross-vein R_{4+5} to M often very faint, and cross-vein M_{3+4} to Cu_1 not always definitely present.

Genitalia ♂, 9th tergite medianly slightly bilobed, with two patches of minute scabrosities separated by a narrow median space, margin with long hairs each arising from a small tubercle, these tubercles often strongly developed, in which case the margin appears scalloped, even with a median point (Ceres); 10th tergite bilobed with a rather deep triangular or semi-circular (Ceres) incision, and lateral setose knobs; penis apically bifurcate; 2nd joint of clasper very indistinctly articulated, apically acute. ♀ terminal tergite rounded, somewhat cowl-like, with flap on either side of anal opening, margin of flap serrated for the most part, and ending in three digitiform processes; subanal plates rounded-quadrangular.

Lateral tuft-like filaments on abdominal segments 2–7.

Fore-wing ♂ 7–8 mm., ♀ 8–9 mm. Antennae 7–8 mm.

Head and thorax dark brown with greyish or golden-grey hairs. Fore-wing sepia-brown with pale or whitish speckling, in fresh specimens with pale golden pubescence, the speckling composed of squarish or roundish spots arranged close together between each pair of veins, in fresh specimens developed over the whole of the wing, but in worn specimens visible only in apical portion, if at all. Hind-wing paler, uniform. Antennae fuscous, annulate. Maxillary and labial palps, and legs pale fuscous. Abdomen sepia-brown with a pinkish tinge (madder-brown).

Egg-mass.—Eggs cemented in a single layer in irregular patches, 5–20 mm. or more in diameter, to stones and boulders under water. Eggs oval, ·5 × ·25 mm., pale pinkish, becoming brownish as the embryos develop (*cf.* Silfvenius, 1906, pp. 25, 26).

Ventro-lateral	
I	2
II	3
III	3
IV	3
V	3
VI	3
VII	(0) 1

Larva.—Head dorsally gently convex. Anterior margin of clypeus convex, or irregular, with a more or less marked notch on the left side, sometimes even slightly concave, always minutely crenulate. Labrum protractile, with strong brush-like fringe of hairs laterally. Internal tuft of setae on left mandible only. No prosternal spine. Mid and hind femora and tibiae with stout fimbriate spines as well as longer and shorter setae. Minute lateral processes on abdominal segments 3–7. Gills ramose; two sternal gills between the middle legs, and three between the hind legs; on the abdomen each main stalk is counted as one gill. Where there are three main stalks the single one lies slightly more medial than the other two, which arise almost contiguously. Anal gills 4.

Up to 12–15 mm.

Head fulvous or dark brown, lighter around the eye and on hind margin. Pro-, meso-, and metanotum dull ochraceous or brownish, with narrow black lateral margins, hind margin of pronotum with narrow black line, a short transverse or crescentic black mark in middle of hind margin on meso- and metanotum; hind margin of prosternum dark brown or blackish. Abdomen grass-green or dark green. Legs ochraceous. Gills whitish.

Pupa.—Antennae extending to middle or end of abdomen, wing sheaths to middle of abdomen. Wing sheaths of both fore- and hind-wings acutely pointed. Middle leg expanded, especially in ♀, tarsus fringed

in both sexes. Dorsal presegmental plates on segments 3–8, postsegmental also on segments 3 and 4, these latter transversely ovate and larger than the presegmental plates, especially that on segment 3; the presegmental plates bear from five to ten crotchets, the number diminishing posteriorly, the postsegmental plates on segment 3 bear many spines, those on segment 4 7–8 spines. Lateral finger-like processes on segments 3–7, that on segment 3 single, that on segment 7 double, those on the other segments triple. Ventral gills

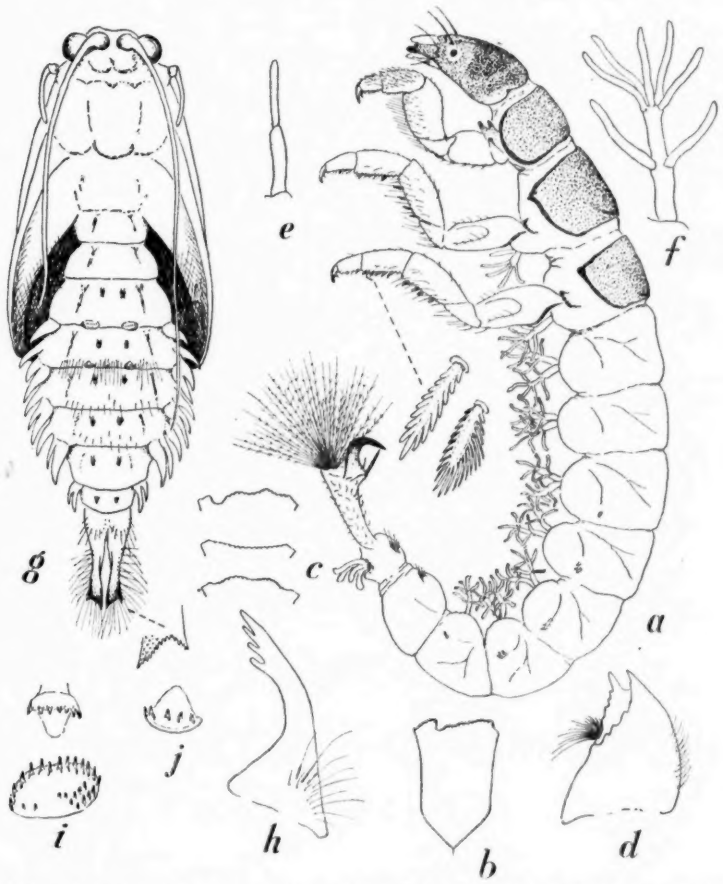

FIG. 38.—*Hydropsychodes lateralis* n. sp. *a*, larva, with spines from mid and hind legs further enlarged; *b*, clypeus; *c*, variations in front margin of clypeus; *d*, left mandible of larva; *e*, *f*, gill of juvenile, 4 mm. in length, and of adult larva respectively; *g*, pupa, with apex of anal appendage further enlarged; *h*, mandible of pupa; *i*, dorsal plates of 3rd segment of pupa; *j*, postsegmental dorsal plate of 4th segment.

absent on thoracic sternites and 1st abdominal segment, present as paired stalks on segments 2–6, and single on segment 7, all postsegmental in position.

Up to 8–10 mm.

Brownish; abdomen green in freshly turned pupa, becoming brown as the imago develops.

Case composed of sand-grains cemented to underside of stones. The pupa as it lies in its case has the abdomen hunched up and dorsally convex, the anal appendages being recurved over the back.

Localities.—Table Mt. slopes, Cape Peninsula (K. H. B., various dates); Stellenbosch (R. M. Lightfoot, October 1916); Jonkershoek, Stellenbosch (K. H. B. and H. G. W.); Groot Drakenstein (A. C. H., October

1931); Witte River, Wellington Mts. (K. H. B., November 1922 and October 1931); Du Toit's Kloof, Rawsonville (K. H. B., March 1932); Hex River, near Worcester (A. C. H., October 1931); Naudesberg, Worcester (K. H. B. and H. G. W., August 1932, larvae and pupae); Gt. Winterhoek Mts. (K. H. B. and R. M. L., November 1916); northern slopes of Matroosberg, Ceres Div. (R. M. Lightfoot, November 1917); Houw Hoek and Genadendal, Caledon Div. (K. H. B., October 1931, larvae); Palmiet River (H. G. W., July 1932, pupa); Lemoenshoek, Langeberg Range, near Heidelberg, Cape (K. H. B., November 1927); Cango (K. H. B. and H. G. W., February 1932, larvae and pupae); Olifants River Mts., near Citrusdal (K. H. B., September 1932, and H. G. W., March 1933); Cedar Mts., Clanwilliam (K. H. B., September 1923 and January 1930); Henkries, Bushmanland (R. M. Lightfoot, October 1911); Montagu Hot Springs (H. K. B., Sept. 1933, larvae).

Remarks.—Very like *thomasseti*, but rather larger and distinctly greyer and more infuscate. The Ceres specimens show that the 9th and 10th tergites may vary slightly, as in the case of specimens of *zuluensis* from different localities.

This is a very common and widely distributed species in the western Cape Province. Its easterly extension to Cango, near Ooudtshoorn, is based on larvae and pupae only. The flies appear in September and continue, in a succession of broods, until March or April.

Hydropsychodes lesnei Mosely.

Mosely, 1932D, p. 4, pl. i, figs. 1–5.

Imago.—In hind-wing Sc and R separate throughout to margin, and not connected by a cross-vein.

Genitalia ♂, 9th tergite convex (apparently interrupted in middle line) with two small tubercles, each bearing two long setae; 10th tergite quadrangular, apical margin slightly sinuous, each lateral angle forming an acute upturned tooth; penis bifurcate.

Fore-wing 6·5 mm.

Head fuscous with fuscous hairs. Antennae, palps, and legs ochraceous, the antennae annulate. Fore-wing greyish-yellow with dark irrorations.

Locality.—Chemba, Zambesi, Portuguese East Africa (Mosely).

Remarks.—Mosely mentions another specimen from Macequece which may belong to this species.

Sciadorus n. g.

Imago.—Mid leg of ♀ not expanded. Claws of ♂ normal. Antennae rather slender, each joint from the 3rd onwards with a dorsal hemiwhorl of setae, giving a serrate appearance, especially distally. Maxillary palp, 1st joint short, 2nd, 3rd, and 4th joints subequal, longer than 1st. In fore-wing discoidal and median cells closed, forks 1, 2, 3, 4, 5, forks 1 and 3 with rather long stalks, no additional costal cross-vein. In hind-wing discoidal cell closed, median cell open, forks 2, 3, 5 (in one case a minute fork 1), Sc and R separate to margin, but united by a cross-vein, similarly R and R_{2+3}. Cross-vein from R_{2+3} to R_4 may be more distal than in figure so that fork 2 becomes definitely sessile. Abdomen with a pair of ventro-lateral filamentous processes on 5th segment, each perforated by a fine canal arising from an internal sac. Two pairs of internal vesicles opening on hind margins of segments 6 and 7.

Lateral tuft-like appendages on segments 2–7.

Genitalia ♂, 10th tergite bifid, penis apically truncate; ♀ similar to that of *Hydropsychodes*.

Larva.—In general like that of *Hydropsychodes lateralis*, but with the clypeus very broad, the plaque d'appui conical (not bifid), no sternal gills between the middle pair of legs, and five anal gills.

Pupa.—Like that of *H. lateralis*, but with presegmental dorsal plates on segments 2–8, and postsegmental on segments 3–5, the *presegmental* plates on segment 3 being the largest, and all the postsegmental plates small; and a pair of ventro-lateral processes on 5th abdominal segment.

Remarks.—But for the absence of fork 1 in the hind-wing this form might be included in the genus *Diplectrona*. The antennae are noticeably slender.

The description of the internal vesicles is given above. The name refers to the Zwartberg or Black Mountain Range, with its deep shadows in the evening light, where one of the species was first captured.

Genotype: *S. acutus* n. sp.

Sciadorus acutus n. sp.

(Fig. 39 *j–n.*)

Imago.—Genitalia ♂, 9th tergite in dorsal view tapering to a sharp point, 10th tergite widely and shallowly excised, each lobe ending in a short incurved point, with lateral setose knobs; penis simple, apically truncate; clasper slender, apical joint short. ♀ lobes of the 8th sternite subtriangular.

Fore-wing ♂ 5 mm., ♀ 6–6·3 mm.

Head and thorax dark brown with paler hairs. Wings pale brown with darker neuration; in fore-wing distal cross-vein of discoidal cell with circular clear or whitish spot, upper margin of median cell and distal portion of Cu_2 clear or whitish; in hind-wing proximal portion of M_{1+2} and greater portion of Cu_2 clear. Abdomen dark brown, lighter along the sides, tuft-like appendages dark, processes of 5th segment pale. Legs ochraceous. Antennae brown.

Larva.—Middle and hind femora and tibiae with fimbriate spines as well as longer and shorter setae (as in *H. lateralis*). Chitinous parts amber with black marks as in *H. lateralis*; the black lateral margin of meso- and metanotum is continued up across the dorsum, and in dorsal view the hind margin of the mesonotum appears distinctly trilobed, and that of the metanotum shallowly excised. Up to 8–9 mm.

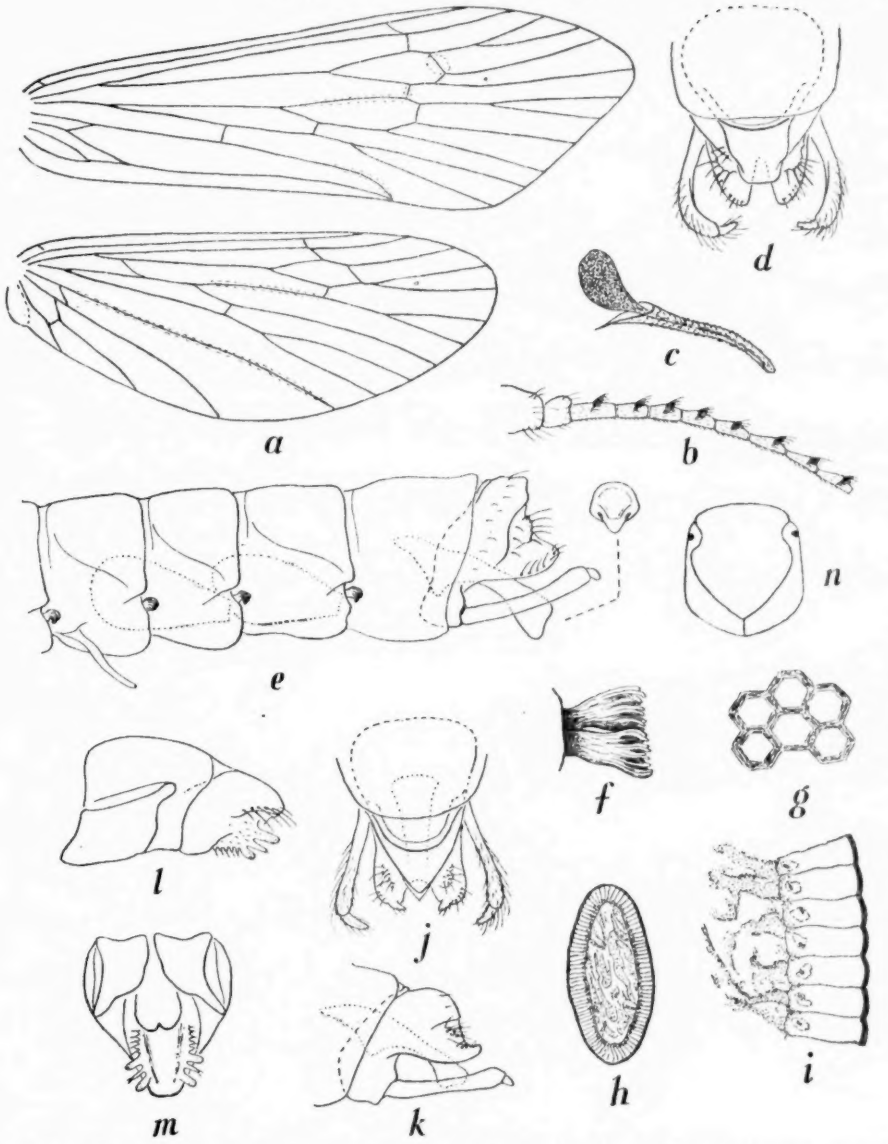

FIG. 39.—*Sciadorus obtusus* n. g., n. sp. *a*, fore- and hind-wings, dotted areas clear; *b*, basal portion of antenna; *c*, ventro-lateral process of 5th abdominal segment, with its internal sac; *d*, dorsal view ♂ genitalia; *e*, lateral view of segments 5–8 and genitalia ♂, showing ventro-lateral process of 5th segment, fan-like bunches of filaments, internal vesicles opening on hind margins of segments 6 and 7, and apex of penis in posterior view; *f*, fan-like bunch of filaments; *g*, surface view of portion of internal vesicle; *h*, section of vesicle; *i*, portion of vesicle further enlarged. *S. acutus* n. sp. *j*, *k*, dorsal and lateral views ♂ genitalia; *l*, *m*, lateral and ventral views ♀ genitalia; *n*, dorsal view of head of larva.

Pupa.—Anal appendages relatively shorter than in *H. lateralis*, the apices rather strongly denticulate.

Localities.—French Hoek Mts., 2000 feet (K. H. B. and H. G. W., December 1932, ♂♂, ♀, larvae, and pupae); Hottentots Holland Mts., 4000 feet (K. H. B. and H. G. W., January 1933, ♂♂, ♀).

Sciadorus obtusus n. sp.

(Fig. 39 *a–i.*)

Imago.—Genitalia ♂, 9th tergite in dorsal view with apex obtusely rounded or subtruncate, 10th tergite with deep rounded excision, the lobes apically rounded; penis and clasper as in *acutus*.

Fore-wing ♂ 7·5–8·5 mm., ♀ unknown.

Colour and clear spaces on wings as in *acutus*.

Localities.—Zwartberg Range at following localities: Zwartberg Pass (K. H. B., November 1929, 1 ♂); Seven Weeks Poort, Boschluis Kloof, Zwartberg Pass and Spitzkop (Meiring's Poort Berg) (K. H. B. and H. G. W., February 1932, ♂♂). All localities at 3000–5000 feet.

Remarks.—A larger species than *acutus*, but closely allied. It was the first species discovered, but as no ♀♀ were found it is preferable to make *acutus* the genotype, of which latter species both sexes and also the larval and pupal stages are known.

Subfamily Macronematinae.

Imago.—Tibial spurs various. Mid leg ♀ expanded, sometimes very strongly; in ♂ slightly or not at all. Claws always normal. Antennae much longer than fore-wing. Maxillary and labial palps sometimes wanting or rudimentary; when present 5th joint of maxillary palp as long as the others together. Fore-wing with discoidal cell closed, open or wanting. Median cell present. Sometimes additional costal cross-veins. Shape of fore-wing and neuration often different in the two sexes. Forks 1, 2, 3, 4, 5, seldom 1, 2, 3, 4; fork 1 always stalked. Hind-wing broader than fore-wing, no closed discoidal or median cells; Rs often forking only at the anastomosis and thus forming a "subdiscoidal" or pseudodiscoidal cell; forks 2 and 3 always present, 5 seldom absent, 1 sometimes present.

Key to the African genera.

1. Palps absent (or rudimentary). Wings glassy, nearly or quite naked.
   - *a.* Fore tibia without spurs. Discoidal cell absent. Median cell very large, quadrangular.
     - i. Tibial spurs 0, 2, 2. Hind-wing with fork 2 stalked (in S. Afr. species) . . . *Chloropsyche.*
     - ii. Tibial spurs 0, 3, 2. Hind-wing with fork 2 sessile (in S. Afr. species) . . *Aethaloptera.*
   - *b.* Tibial spurs 1, 3, 3, or 2, 3, 3. Discoidal cell present. Median cell triangular. Fore-wing with fork 2 sessile . . . . . *Polymorphanisus.*
2. Palps well developed.
   - *a.* Fore-wing with discoidal cell open or absent.
     - i. Tibial spurs 2, 4, 2. Subdiscoidal cell present. Sc and R fused in part in fore-wing. Fork 1 absent in hind-wing . . . . . *Phanostoma.*
     - ii. Tibial spurs 0, 4, 4. Subdiscoidal cell absent. Sc and R separate throughout. Fork 1 in hind-wing present . . . . . *Protomacronema.*
   - *b.* Fore-wing with discoidal cell closed. Mid leg ♂ not or scarcely expanded.
     - i. In hind-wing fork 5 longer than fork 2. 2nd joint maxillary palp longer than 3rd. *Leptonema.*
     - ii. In hind-wing fork 5 shorter than fork 2. 2nd joint maxillary palp shorter than 3rd. *Macronema.*

Gen. *Aethaloptera* Brauer.

Ulmer, 1907, p. 156; 1912, p. 120 (larva). Navas, 1915, p. 181 (*Primerenca*). Lestage, 1919A, p. 293.

Imago.—Tibial spurs 0, 3, 2. Mid leg slightly expanded in ♂, strongly so in ♀. Head with two warts at base of antennae. Antennae in ♂ about 3 times as long as fore-wing, in ♀ about 1½. Palps absent. Wings naked. Fore-wing long and narrow, apically widened. Additional costal cross-veins present. Discoidal cell closed, median cell large, quadrangular; forks 1, 2, 3, 4, 5; forks 1 and 2 stalked, the latter arising from a minute cell enclosing the wing-spot (nygme), fork 4 sessile or stalked, 5 incomplete. Hind-wing very broad at base; forks 1, 2, 3, 5; fork 1 stalked, 2 stalked or sessile, 3 and 5 sessile.

Larva.—Ulmer (1912) has provisionally assigned to this genus a larva with flattened head, very strong mandibles, and two stout spines or denticles at bases of mid and hind claws (see *infra*).

Remarks.—The genus is found in Africa, East Indies, India, and Siberia. The occurrence of the Indian species *sexpunctata* in Cameroon is doubtful (Lestage, 1919, pp. 261, 298).

Aethaloptera dispar Brauer.

(Fig. 40 *a.*)

Brauer, 1875, p. 72, pl. iv, figs. 4, 4 *a–c*. Ulmer, 1905, p. 25; 1907, p. 157, pl. xxi, fig. 193. Navas, 1915, p. 182, fig. 6 (*Primerenca maesi*); 1930A, p. 328; 1931A, p. 141; 1932, p. 288. Lestage, 1919A, p. 293.

Imago.—Fore-wing distally rather broadly rounded. Hind-wing with fork 2 sessile.

Genitalia ♂, 9th tergite projecting, rounded-triangular, 10th tergite deeply cleft, each lobe in lateral view triangular, in dorsal view narrow and slightly twisted (propeller-like); penis slender in middle, distally widening to a bulbous apex; clasper elongate, slender, obscurely 2-jointed. ♀ *cf.* Brauer's description and fig. 40 *f, g, infra.*

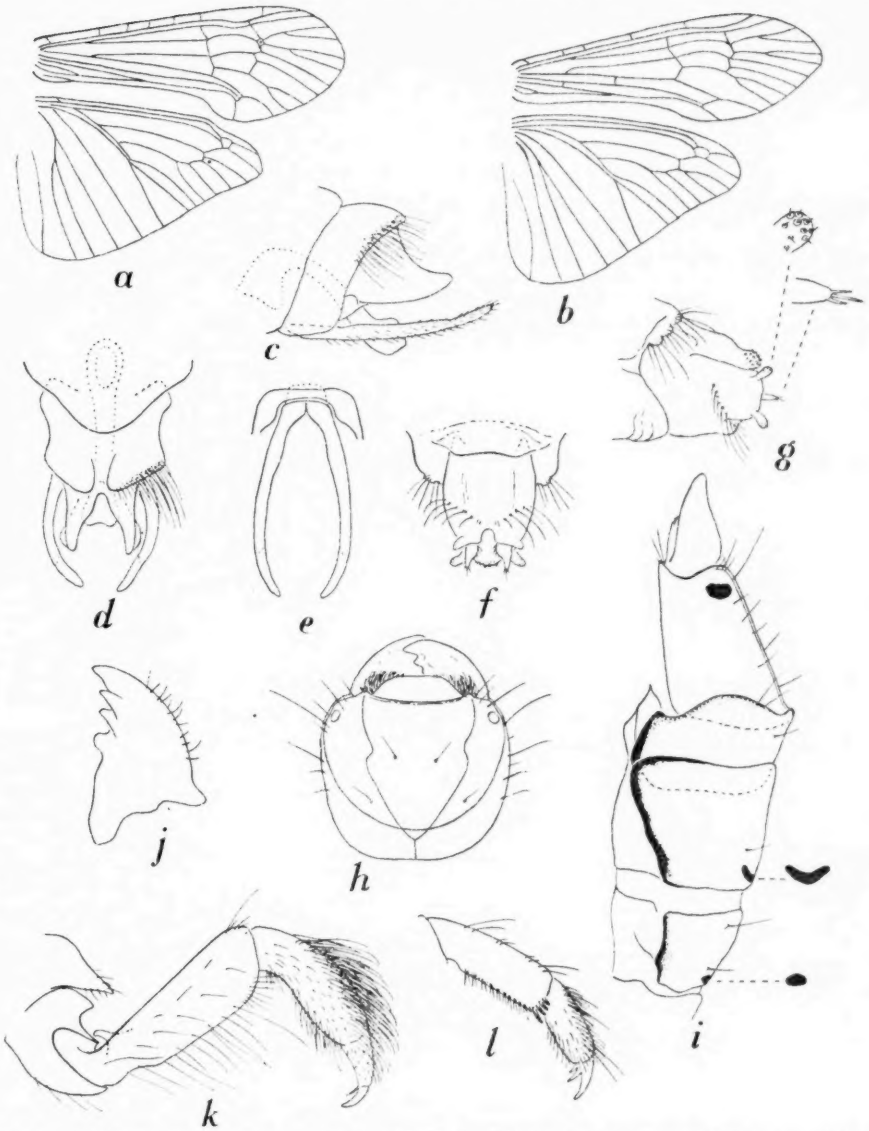

FIG. 40.—*Aethaloptera dispar* Brauer. *a*, fore- and hind-wings (Nyassaland specimen ex-Brit. Mus.). *Chloropsyche maxima* (Ulmer). *b*, fore- and hind-wings; *c*, *d*, *e*, lateral, dorsal, and ventral views genitalia ♂ (Kunene River and Prieska; the same figure applies to the Nyassaland specimen of *Aethaloptera dispar*); *f*, *g*, ventral and lateral views genitalia ♀ (Kunene River).

Natal larva provisionally assigned to *Chloropsyche*. *h*, dorsal view of head; *i*, lateral view of head and thorax, with meso- and metanotal spots in dorsal view; *j*, left mandible; *k*, *l*, outer or posterior view of fore and mid legs.

Fore-wing ♂ 10–16 mm., ♀ 8–9 mm. Body 7–8 mm.

Head and thorax pale fawn with white hairs. Legs and antennae ochraceous, the latter with white or narrow black annulations. Wings pale horn-colour or almost colourless, fore-wing frequently of a pale green tint; frequently small black dots on the cross-veins (Cu_1–Cu_2, Cu_2–1A, and the anastomosis).

Localities.—Livingstone, N. Rhodesia (Ulmer); Chiromo, Nyassaland (♂ ex-British Museum, identified by M. E. Mosely).

Distribution.—Senegal, Cameroon, Soudan, Abyssinia (or Egypt), Belgian Congo.

Remarks.—Ulmer and Lestage note several variations both in coloration (*supra*) and neuration. As regards the latter, whereas forks 1 and 2 in fore-wing seem to be always stalked, and fork 3 sessile in both sexes, fork 4 is usually stalked in ♂, sessile in ♀, but the reverse may occur. The minute cell enclosing the wing-spot is also variable.

As regards the ♂ genitalia, the Nyassaland specimen I have examined agrees with Brauer's figures, except that Brauer places the long hairs farther forward on the 9th tergite instead of on the posterior margin. Navas's and Lestage's figures of the 10th tergite are in a sense correct, but the recurved or hamate appearance of the apex is due to the unequal chitinisation of the lobes, the margins appearing darker than the rest. Lestage is in error in describing this structure as the penis. Neither Navas nor Lestage show the penis, but Brauer shows it in its correct position.

The Nyassaland ♂ specimen is interesting in having the mid legs not dilated, and only two spurs on the right mid tibia.

Gen. *Chloropsyche* McLach.

Ulmer, 1907, p. 156; Lestage, 1919A, p. 292.

Imago.—Differing from *Aethaloptera* only in having tibial spurs 0, 2, 2 and the mid leg not dilated in ♂.

Remarks.—The genus is recorded from Siberia and South Africa.

The question may well be asked whether there is any justification for maintaining this genus as distinct from *Aethaloptera*. There is a difference in the tibial spur formula. One case is noted above where this does not apply, the left mid tibia having three spurs, while the right has only two. I see no difference in the width of the mid leg in a ♂ *dispar* (identified by Mosely) and the Prieska ♂ identified by Ulmer as *C. maxima*.

The ♂ genitalia of the Nyassaland *dispar* are exactly the same as those of the Prieska specimen, and several others from the Kunene River. Ulmer (1906, p. 63) stated that the original example of *maxima* did not differ in the genitalia from *dispar*, and he described it as an *Aethaloptera*. As regards fork 2 in hind-wing, this appears to be sessile in *dispar*, stalked in *maxima*. But it is sessile in the Siberian *C. evanescens* and apparently stalked in *A. sexpunctata* (but for latter see Lestage, 1919A, pp. 296, 297).

In practice this latter character may be used to separate *maxima* and *dispar*, and for the present the two genera may be accepted.

Chloropsyche maxima (Ulmer).

(Fig. 40 *b–g.*)

Ulmer, 1906, p. 62, fig. 66 (*Aethaloptera m.*); 1907, p. 156; 1913, p. 191. Lestage, 1919A, p. 293. Mosely, 1932D, p. 5 (*Aethaloptera m.*).

Imago.—Fore-wing distally rather narrower than in *A. dispar*. Hind-wing with fork 2 stalked.

Genitalia ♂, as in *A. dispar*. ♀ penultimate tergite with slight lobes on either side of median line, terminal segment dorsally rounded and slightly upturned, minutely scabrous, 2 short, in lateral view truncate, flaps each bearing three digitiform processes.

Fore-wing ♂ 16–18 mm., ♀ 9–10 mm. (Natal ♀ 13 mm.).

Coloration as in *A. dispar*. Black dots on fore-wing present or absent.

Localities.—Bothaville, O.F.S. (Ulmer); Prieska, Cape (Ulmer); Mooi River, Natal (S.A. Mus.); Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, ♂♂, ♀♀); Chemba and Tambara, Zambesi, Portuguese East Africa (Mosely).

Uncorrelated larva of ? *Chloropsyche*.

(Fig. 40 *h–l.*)

Cf. Ulmer, 1912, p. 120, figs. 48–50 (*Aethaloptera*).

	Ventral and Ventro-lateral.	Dorso-lateral.
I	3	—
II	3	1
III	3	1
IV	3	1
V	2 (3)	1
VI	2	1
VII	1	1

Head dorsally flattened, bounded by a semi-circular rim which passes through posterior end of clypeus. Anterior margin entire, slightly concave. Clypeus broad, lateral margin indented. Labrum protractile, with strong lateral brushes of setae. Mandibles stout, knife-like, cutting edge dentate but asymmetrical on the right and left mandibles, no internal tuft on left mandible. Maxillae and labium present, typical (as in family). Prosternal spine absent; posterior margin of prosternum slightly chitinised. Plaque d'appui ending in a single acute point. Front coxa with triangular point; femur with recurved process at base on inner (anterior) side; tibia and tarsus with dense brush of glistening silvery setae on outer anterior margin; claw with slender basal spine. Mid and hind tibiae with 4–5 stout spines on outer (posterior) apical margin; lower margin of tibiae and tarsi and upper margin of tarsi with series of close-set bristles, more numerous on mid leg than hind leg; claw of both mid and hind legs with two conical spine-like denticles. Gills branched; two mesosternal between mid legs, four metasternal between hind legs; dorso-lateral and ventral (ventro-lateral) abdominal as in diagram.

Up to about 15 mm.

Head deep fulvous (as preserved), almost castaneous. Pro-, meso-, and metanotum fulvous-ochraceous, a medio-dorsal crescent-shaped black spot on hind margin of mesonotum, a smaller oval spot on hind margin of metanotum. Abdomen yellowish-white. Gills white.

Locality.—Natal (L. A. Day).

Remarks.—Ulmer provisionally referred his Cameroon larvae to *Aethaloptera*. As *Chloropsyche maxima* is recorded from Natal, there is every likelihood of the larva here described belonging to this latter species. If so it would be further evidence of the very close relationship, if not identity, of the genera *Aethaloptera* and *Chloropsyche*. It should not be difficult for Natal naturalists to correlate definitely the adult of this very distinctive larva, and also to discover the habits of the latter. As Ulmer says, the shape of the head suggests burrowing habits; the glistening brush of setae on the fore legs is evidently for some purpose.

Gen. *Polymorphanisus* Wlkr.

Ulmer, 1907, p. 157. Lestage, 1919A, p. 299. Navas, 1931, p. 276; 1931A, pp. 139 *sqq*.

Imago.—Tibial spurs 2, 3, 3, or 1, 3, 3. All legs dilated, the mid leg most strongly, and with fringe of stiff bristles, hind leg of ♂ and fore leg of ♀ least dilated. Palps absent. Head with two warts behind bases of antennae, and a transverse ridge posteriorly (interrupted in middle line), face smooth and glassy. Wings naked; fore-wing long and narrow, more pointed in ♂ than ♀; with additional costal cross-veins, discoidal cell closed, usually as broad as long, median cell triangular, forks 1, 2, 3, 4, 5. One stalked and 5 complete. Hind-wing broader than fore-wing, forks 2, 3, 5 always present, 5 very short, 1 present or absent. Mesonotum usually with two black spots.

Remarks.—The distribution covers Africa and India, East Indies and the Philippines.

Polymorphanisus bipunctatus (Brauer).

Ulmer, 1907 (Coll. Selys., fasc. vi, pt. 2), p. 20, figs. 4, 6–9; 1907, p. 157, pl. xxi, figs. 191 *d*, *e*, 194; 1913, p. 191. Lestage, 1919A, pp. 299, 300. Navas, 1930A, p. 329; 1931, p. 276; 1931A, p. 139; 1932, p. 288.

Imago.—Tibial spurs 1, 3, 3. Fore-wing with median cell extending farther proximal than the very short discoidal cell. Hind-wing with fork 1.

Genitalia ♂ (Ulmer, 1904, figs. 2, 3, and 1907, Selys., fig. 9) in general similar to those of *A. dispar*.

Wing expanse 30–52 mm., ♂ usually smaller than ♀. Pale buff, abdomen darker, wings almost colourless. Head and anterior part of pronotum and the wings often with a pale greenish tinge. Antennae yellowish and annulate, or blackish. The black spots on mesonotum may disappear.

Localities.—M'fongosi, Zululand (Ulmer); Weenen, Natal (Lestage); Wankie, S. Rhodesia (S.A. Mus.).

Distribution.—Tropical Africa (including Belgian Congo).

Remarks.—This is the largest South African Caddis-fly. It is often caught at light. Up to the present its larva is quite unknown.

Gen. *Phanostoma* Brauer.

Ulmer, 1907, p. 159; Navas, 1927, p. 214.

Imago.—Tibial spurs 2, 4, 2, spurs of fore tibia very small. Mid leg (distal end of tibia slightly, first 3 tarsal joints strongly) expanded ♂. Palps present. Two pairs of warts on head. Wings naked. Fore-wing long and narrow, apically broadened, with additional costal cross-veins. Discoidal cell faintly indicated; subdiscoidal cell present. Sc and R fused in part. Stalk of fork 1 very near to, or fused with, R_4. Hind-wing with fork 1 absent.

Genitalia ♂ very similar to those of *Aethaloptera*.

Remarks.—One species widely distributed in tropical Africa, and one species (*curvinerve* Navas) from Egypt.

Phanostoma senegalense Brauer.

Brauer, 1876, p. 71, pl. iv, figs. 5–5 *e* (wings, ♂ genitalia). Ulmer, 1905, p. 26, fig. 12; 1907, p. 159, pl. xxi, fig. 198; 1912, p. 98. Lestage, 1919A, p. 301. Navas, 1931, p. 277; 1932, p. 288. Mosely, 1932D, p. 5, pl. i, fig. 6 (♂ genitalia).

Imago.—Pale yellowish-brown or greenish. Fore-wing pale yellowish, with a greyish suffusion from pterostigmal area to thyridial cell. Fore-wing 13 mm.

Locality.—Chiramba, Portuguese East Africa (Mosely).

Distribution.—Senegal (Brauer); Fort Archambault, Chari River, French Equatorial Africa (Ulmer); Togo (Ulmer); Congo (Ulmer and Navas).

Remarks.—Brauer gives three views of the ♂ genitalia, but Mosely gives a better dorsal view.

Gen. *Protomacronema* Ulmer.

Ulmer, 1907, p. 161; Lestage, 1919A, p. 302; Navas, 1930A, p. 329.

Imago.—Tibial spurs 0, 4, 4. Mid leg in ♂ scarcely, in ♀ strongly, expanded. Head with two warts behind bases of antennae. Palps present. Wings pubescent. Fore-wing with discoidal cell open or absent, no subdiscoidal cell; forks 1, 2, 3, 4 ♂, 1, 2, 3, 4, 5 ♀; Sc and R separate throughout. Hind-wing very broad

at base; forks 1, 2, 3, 5. A pair of small ventro-lateral knob-like appendages on abdominal segment 5 in ♂, but no tuft-like appendages.

Remarks.—The genus is entirely African and Madagascan. The discovery of the small abdominal appendages in the ♂ invites comparison with *Centromacronema*. The other species of the genus should be examined to see whether they also possess these structures.

Protomacronema pubescens Ulmer.

(Fig. 41 *a–e.*)

Ulmer, 1904, p. 417, figs. 4–8; 1905B, p. 48, pl. i, figs. 36–39 (*Amphipsyche africana*); 1913, p. 191. Lestage, 1919A, p. 303. Navas, 1930A, p. 329; 1931, p. 277; 1931A, p. 141. Mosely, 1932D, p. 5.

Imago.—Fore-wing without marked indentation on distal margin.

Genitalia ♂, 9th tergite in dorsal view slightly convex medianly, 10th tergite deeply cleft, each lobe produced dorsally in a slender process apically curved outwards slightly and spinulose, ventro-posterior margin (lateral view) rather strongly chitinised; penis slightly enlarged apically with two stout spines; clasper slender, especially the 2nd joint. ♀ similar to that of *Hydropsychodes lateralis* (fig. 37 *e, f*), with exactly similar digitiform processes on the ventro-lateral flaps.

Fore-wing 10–13 mm.

Head and thorax ochraceous. Fore-wing fulvous or pale buff, with pale golden or whitish pubescence in fresh specimens, with a transverse hyaline or pale bar along the anastomosis, bordered with darker brown. Legs and antennae buff, the latter narrowly annulate.

Localities.—M'fongosi, Zululand (Ulmer); Chiramba, Zambesi, Portuguese East Africa (Mosely).

Distribution.—West Africa (specimens from the Belgian Congo may be a different species).

Remarks.—Ulmer (1907, Coll. Selys., fasc. vi, pt. 2, p. 36, figs. 29, 30) described Congo specimens with the *eighth* tergite, under which the genitalia are retracted, medio-dorsally deeply cleft. When the genitalia are drawn out the long setae are really situate on the narrow dorsal margin of the 9th tergite. In any case there is no such cleft in the 8th or 9th tergite of the South African specimen, and the question therefore arises whether this specimen should be assigned to *pubescens*. As a Sierra Leone specimen (ex-Brit. Mus. determ. Mosely) agrees with the Zululand specimen, and there is no indication of the cleft in Ulmer's description of the original Cameroon specimen (1904, p. 417, figs. 7, 8), it seems that the Congo specimens figured by Ulmer in 1907 belong to another species. In dried specimens the lobes of the 10th tergite, penis, and claspers are folded dorsally, the 10th tergite and penis being retracted within the 9th tergite, and this within the 8th tergite, which thus forms a kind of cowl.

Gen. *Leptonema* Guèrin.

Ulmer, 1907, p. 162; Lestage, 1919A, p. 303 *; Navas, 1930A, p. 330; Banks, 1920, p. 357.

Imago.—Tibial spurs 2, 4, 4, or 1, 4, 4. Mid leg seldom dilated, in ♀ often only flattened. Head nearly smooth dorsally. Palps present; 2nd joint of maxillary palp long, always distinctly longer than 3rd. Wings pubescent; fore-wing with discoidal cell closed, mostly triangular, and additional costal cross-vein; forks 1, 2, 3, 4, 5, only fork 1 stalked. Hind-wing broader than fore-wing, forks 2, 3, 5, 5 very long, longer than 2. Sc and R in both wings usually confluent distally.

Genitalia ♂, penis smooth in African species, spinose in American species.

Remarks.—Distributed over America, Africa, and India.

Leptonema occidentale Ulmer.

(Fig. 41 *f–i.*)

Ulmer, 1907, p. 163, fig. 205; 1913, p. 191. Lestage, 1919A, p. 304.

Imago.—Tibial spurs 1, 4, 4. Fore-wing with discoidal cell moderately large. Sc and R typically separate, but in the present specimen apically confluent. Median cell broader than in Ulmer's figure.

Genitalia ♂, 9th tergite slightly emarginate, 10th tergite cleft to base, each lobe somewhat twisted, and with a basal knob on outer surface; penis elongate, apically expanded, not spinose; clasper long, 2nd joint very short.

Tuft-like appendages laterally on segments 2–7 in ♂, as in *Hydropsychodes*. Sternite of 5th abdominal segment in ♂ also with a pair of oblique oval bare patches (see also p. 358).

Fore-wing 11–12 mm.

Head and thorax fuscous. Wings pale umber-brown. Legs and antennae ochraceous, the latter annulate.

Locality.—Barberton, Transvaal (Ulmer).

Distribution.—Cameroon.

Remarks.—Ulmer says these specimens are darker than the typical ones. He seems to have overlooked the fusion of Sc and R in fore-wing, which makes these specimens more like the Madagascan species.

* In the key to the Macronematine genera on p. 292 some of the characters given do not seem to be in keeping with Ulmer's diagnosis.

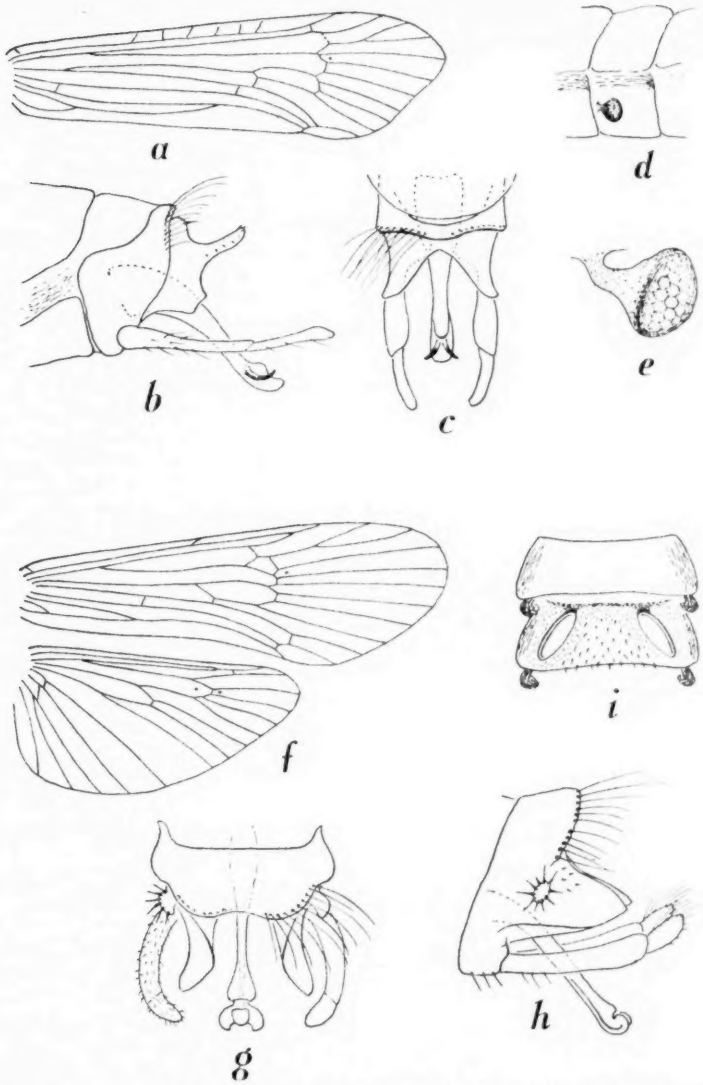

FIG. 41.—*Protomacronema pubescens* Ulmer. *a*, fore-wing; *b*, *c*, lateral and dorsal views ♂ genitalia, in *b* the area between 8th tergite and 9th segment is membranous, and the 10th tergite and penis have been pulled out from the 9th segment; *d*, lateral view of 5th abdominal segment ♂, with knob-like process; *e*, process further enlarged (specimens from M'fongosi). *Leptonema occidentale* Ulmer. *f*, fore- and hind-wings; *g*, *h*, dorsal and lateral views ♂ genitalia; *i*, ventral surface of 5th abdominal segment ♂ (specimens from Barberton).

Gen. *Macronema* Pictet.

Ulmer, 1907, p. 164; 1912, p. 119 (larva); 1931, p. 2 (list of spp.). Lestage, 1919A, p. 305. Navas, 1932, p. 289.

Imago.—Tibial spurs 2, 4, 4 or 1, 4, 4 or 0, 4, 4. Mid leg in ♂ not, in ♀ not strongly, expanded. Head with two large warts behind bases of antennae, and two smaller ones behind these, often also a median tubercle. Palps present, 2nd joint of maxillary palp shorter than 3rd. Wings feebly pubescent or naked. Fore-wing usually without additional costal cross-vein, discoidal closed, narrow-triangular; forks 1, 2, 3, 4, 5, only fork 1 stalked, fork 5 sometimes absent in ♂. Hind-wing broader than fore-wing, forks 2, 3, 5, occasionally also 1, 5 shorter than 2. Sc and R in both wings usually confluent distally.

Genitalia ♂, 10th tergite more or less deeply cleft, penis apically knob-like, claspers with 1st and 2nd joints subequal (in African species).

Larva.—See Ulmer (*loc. cit.*). Not definitely correlated. Similar to the larva of *Hydropsyche*. The plaque d'appui is conical, not bifurcate.

Remarks.—A large genus distributed over Asia, North and South America, Australia, and Africa, though comparatively few species in the latter region. Fore-wings usually prettily marked. Filamentous abdominal appendages on 5th segment are present in *capensis* and *natalensis* (presumably in both sexes, but I have not seen any ♀♀); and may possibly be present in other species of the genus.

Key to the South African species and varieties.

A. 5th joint of maxillary palp longer than the others together.
  1. Fore-wing uniform dull yellowish, or with only a few small dots along costa . *capense* (s. str.).
  2. Fore-wing with definite colour-pattern.
    a. A dark Y-shaped bar across apical part.
      i. A dark cross-bar in basal ⅓ (penis, see fig. 42 *f*) . . var. *signatum* (tropical Africa).
      ii. A hyaline spot in basal ⅓ . . . var. *pulcherrimum* (Sierra Leone).
    b. Two dark transverse anastomosing bars across middle of wing, apical portion of wing suffused (penis, see fig. 42 *g*) . . . . . var. *inscriptum*.
    c. Blackish-brown with yellow patches . . . . . var. *rhodesianum*.
B. 5th joint shorter than 2nd-4th together . . . . . *natalense*.

Macronema capense Wlkr.

(Fig. 42 *f*, *g*.)

Ulmer, 1906, p. 74, fig. 75; 1907, p. 166, pl. xxii, fig. 206; 1907 (Coll. Selys., fasc. vi, pt. 2), p. 104, fig. 108, pl. v, fig. 32 (*capense*), fig. 36 (*inscriptum*); 1912, p. 99; 1931, p. 14, fig. 12 (*rhodesianum*). Lestage, 1919A, p. 307. Navas, 1930A, p. 331, fig. 46; 1931A, p. 141; 1932, p. 288.

Imago.—Tibial spurs 2, 4, 4. 5th joint of maxillary palp longer than the others together. Fore-wing with apical margin rounded in both sexes (not slightly emarginate in ♂). Discoidal cell moderate, ⅔ length of median cell, with lower end of its apical cross-vein slightly more distal than upper end. The three cross-veins of the anastomosis nearly in a line with one another. Sc and R confluent. No additional costal cross-vein.

Genitalia ♂, as here figured for *natalense*, but with slight differences in penis.

Fore-wing 10–13 mm.

Head and thorax yellowish, orange, or fulvous. Mesonotum fulvous. Legs ochraceous. Antennae castaneous, dark brown or blackish. Fore-wings variable.

Var. *capense* Wlkr., uniform yellowish-grey, or with faint traces of cross-bars remaining as dark spots on costa.

Var. *inscriptum* Wlkr., pale yellowish, apical portion of wing suffused greyish, two dark cross-bars anastomosing to form a more or less distinct M-shaped mark.

Var. *rhodesianum* Ulm., blackish-brown, with yellow markings, one pterostigmal connecting with a subcircular mark around the anastomosis, one costal, connecting with a bar across middle of wing, widening towards hind margin, and some smaller spots.

Localities.—Var. *capense*, Durban (Walker, Port Natal).

Var. *inscriptum*, Lydenburg, Transvaal (S.A. Mus.); Pungwe and Revoue Valleys, Portuguese East Africa (Ulmer); Mlanje, Nyassaland (spec. ex-Brit. Mus.).

Var. *rhodesianum*, Chirinda Forest, S. Rhodesia (Ulmer).

Distribution (all varieties).—Tropical West and East Africa.

Remarks.—The coloration is very variable in the different forms, though there appears to be little or no morphological difference. Figures are here given of the apex of the penis in vars. *inscriptum* and *signatum* (spec. ex-Brit. Mus.). I fail to see any reason why *rhodesianum* also should not be regarded as merely a variety.

Macronema natalense Ulmer.

(Fig. 42 *a*–*e*.)

Ulmer, 1931, p. 12, fig. 11.

Imago.—Tibial spurs 2, 4, 4. 5th joint of maxillary palp shorter than 2nd–4th joints together. Venation as in *capense*; 1–3 faint, or very faint, additional costal cross-veins.

Genitalia ♂, 9th tergite with hind margin slightly arcuate, with, in the Natal specimens, a small median point; 10th tergite cleft, lobes obtuse in dorsal, triangular in lateral, view; penis apically thickened, dorsal

margin not projecting, within the opening two small chitinous thickenings dorsally and two obtuse papillae ventrally (in the Cape specimens the stalk is very slender proximal to the apical thickening).

Fore-wing 10–12 mm.

Head and thorax yellowish-brown or fulvous. Mesonotum blackish, shiny. Legs ochraceous or somewhat fuscous. Antennae blackish-brown, paler distally. Wings densely pubescent. Fore-wing brownish-grey, with scattered golden-yellow hairs along the longitudinal veins, especially distally, and in a larger spot in thyridial cell; base of wing, a slightly oblique cross-bar in the middle, a pterostigmal spot, area around arculus and apex of R more darkly suffused, without golden hairs; discoidal cell paler, more or less hyaline.

Localities.—Weenen, Natal (Ulmer); Howick, Natal (S.A. Mus.); Pilgrim's Rest, Transvaal (S.A. Mus.); Groot Drakenstein, Cape (A. C. H.); Howieson's Poort, Grahamstown (J. Hewitt).

Remarks.—The above description of the colour is taken from Ulmer and the South African Museum specimens. The Gt. Drakenstein specimen is preserved in alcohol, but the membrane of the wings shows the same slightly suffused areas and the hyaline discoidal cell as described by Ulmer.

But for the difference in the maxillary palp this form might also be regarded as a very dark variety of *capense*.

The Cape specimen lacks the small medio-dorsal point on the hind margin of the 9th tergite ♂.

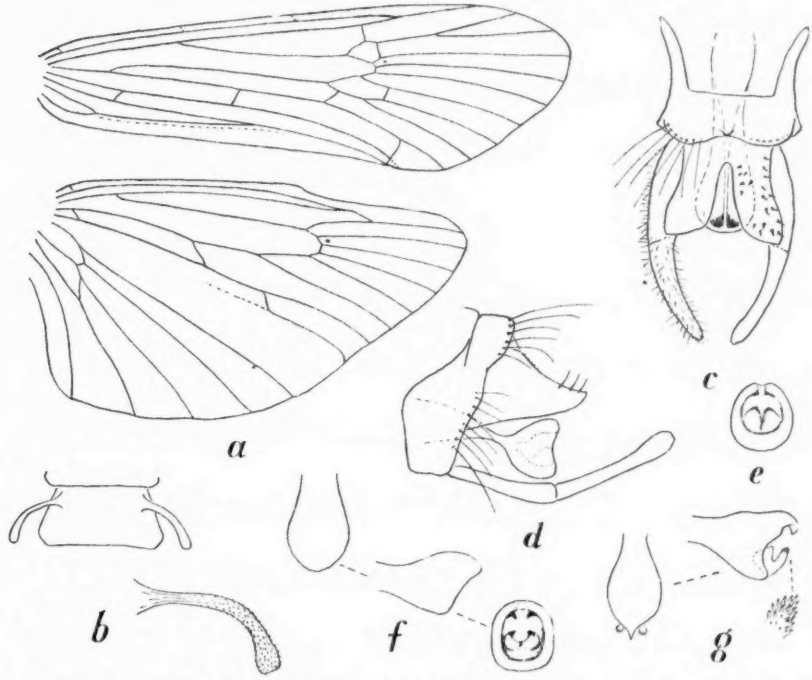

Fig. 42.—*Macronema natalense* Ulmer. *a*, fore- and hind-wings; *b*, 5th abdominal segment, with one of the processes further enlarged; *c*, *d*, dorsal and lateral views ♂ genitalia, the median point on 9th tergite shown in *c* occurs only in Natal specimens, not in the Cape specimen; *e*, end view of penis. *Macronema capense* var. *signatum*. *f*, dorsal, lateral, and end views of penis (specimen from Uganda). *Macronema capense* var. *inscriptum*. *g*, dorsal and lateral views of penis, with apex of one of the ventral processes further enlarged (specimens from Lydenburg and Mlanje).

Family Polycentropidae.*

Ulmer, 1907, p. 179. Banks, 1920, p. 361. Lestage, 1919A, p. 266; 1921, p. 476 (larva and pupa).

Imago.—Tibial spurs 3, 4, 4 (in one case 3, 4, 3). Ocelli absent. Rostral processes sometimes present. Antennae stout, the basal joint scarcely thicker than the others. Maxillary palps 5-jointed ♂, ♀, first two joints

* More correctly, *Polycentropodidae*.

short, 5th long, flexible, segmented. Labial palp 3rd joint segmented. Fore-wing with discoidal and median cells closed, mostly forks 1, 2, 3, 4, 5; fork 1 stalked, seldom absent. Hind-wing with discoidal cell closed or open, median cell open or absent. ♀ without ovipositor (except *Hyalopsyche*).

Egg-mass cemented to objects under water (Ulmer, 1909A, p. 205).

Larva.—Campodeiform. Head large. Antennae rudimentary. Only the pronotum corneous. No prosternal spine. Mandibles chisel-like, dentate, a feeble internal tuft in left mandible only. Maxillary palp 4-jointed, 3rd joint very long. Labial palp rudimentary. Legs short, subequal, mid leg longest, tarsi with apical whorl of bristles, claws slender. Anal appendages long, 3-jointed. Lateral line and gills absent. Five anal gills.

No definite case, living in loosely-spun webs among vegetation.

Pupa.—Robust. Antennae thick, as long as body. Tibial spurs 3, 4, 4. Mandibles sickle-like, slender. Gills present, filamentous. Mid leg slightly expanded in ♀. Mid tarsi fringed. Terminal abdominal segment produced in two blunt lateral, membranous processes.

Case composed of sand-grains or vegetable matter, affixed to stones and other objects.

Remarks.—Formerly included in this family, the *Ecnominae* have been removed by Ulmer to the following family.

The species inhabit either slowly or rapidly running streams or lakes.

Only one genus is known from South Africa.

Key to the African genera (after Lestage).

1. Rostral processes present and well developed. Inner apical spur of hind tibia ♂ modified *Dipseudopsis*.
2. Rostral processes absent, or if present feeble (*Protodipseudopsis*). No modified spurs.
   - *a*. Hind-wing with forks 2, 5. Fore-wing with forks 2, 3, 4, 5. Discoidal cell closed in both wings. Postanal (between 2A and hind margin) area very narrow. *Nyctiophylax* (West Africa, Belgian Congo).
   - *b*. Hind-wing with forks 2, 3, 5. Fore-wing with forks 1, 2, 3, 4, 5. Postanal area broad.
     - i. Maxillary palp with unequal joints . *Protodipseudopsis* (West Africa, Belgian Congo).
     - ii. Maxillary palp with joints subequal. ♀ with ovipositor *Hyalopsyche* (Cameroon, French Congo).

Gen. *Dipseudopsis* Wlkr.

Ulmer, 1905A, pp. 92 *sqq.*; 1907, p. 187; 1911, p. 252; 1912, p. 117 (larva); 1929, pp. 183 *sqq.*; 1931, pp. 5 *sqq.* Lestage, 1919A, p. 271; 1922, p. 212; Banks, 1920, p. 361. Navas, 1930A, p. 324; 1931, p. 274.

Imago.—Tibial spurs 3, 4, 4, inner apical spur of hind tibia in ♂ variously modified. Mid leg ♀ strongly dilated. Antennae about as long as fore-wing. Maxillary palp short, thick, 1st–4th joints compressed, dilated, 5th cylindrical, 2nd considerably longer than 1st. A pair of rostral processes (=enlarged external lobes of 1st maxillae). Prothorax unusually large, with median longitudinal groove. Discoidal and median cells in both wings closed. Fore-wing usually with additional costal cross-vein; forks 1, 2, 3, 4, 5; fork 1 seldom absent, 2 and 4 sessile; postanal (between 2A and hind margin) area broad. Hind-wing with forks 2 and 5.

Genitalia ♂, preanal appendages large, broad, 10th tergite emarginate, claspers, 1-jointed.

Larva.—Head long. Plaque d'appui with slender spiniform process. A similar process on fore coxa. Legs sparsely setose, with short claws. Anal appendages also with short claw. Five anal gills (Ulmer). See also p. 376.

Remarks.—The genus is distributed over China, Japan, India, and the East Indies, Africa, and Madagascar.

Key to the South African species.

1. Inner apical spur of hind tibia ♂ apically abruptly narrowed, the basal portion at least three times the length of apical portion . . . . . *capensis*.
2. Inner apical spur evenly tapering to apex . . . . . *simplex*, *sicumbana*.

Dipseudopsis capensis Wlkr.

(Fig. 43 *a–i*.)

Ulmer, 1905A, p. 95, fig. 72 *a–e* (*fasciata*); 1907, p. 188 (*capensis*) and pl. xxiv, fig. 230 *e* (*fasciata*); 1912, p. 86, fig. 9 *a*, *b* (*fasciata*); 1929, p. 192, fig. 32. Lestage, 1919A, p. 277 (*fasciata*) and p. 281 (*capensis*). Navas, 1930A, p. 323; 1931, p. 274; 1931A, p. 138; 1932, p. 288. Mosely, 1932D, p. 6 (*fasciata*).

Imago.—Inner apical spur of hind tibia ♂ subequal to outer spur, scarcely thicker, straight, apically abruptly narrowed and curved outwards, claw-like, the basal portion at least three times as long as apical portion. Fore-wing with fork 1 absent.

Genitalia ♂, 9th tergite rounded-triangular in dorsal view, 10th tergite sloping downwards, apically rounded with a more or less noticeable indent (according to angle from which it is viewed); preanal appendages large, oval in dorsal view, triangular in lateral view; penis simple, apically rounded; clasper short, stout, in lateral view apically widened, in ventral view apically incurved. ♀ terminal segment with slight notch, two membranous flaps each bearing two oval papillae and between them a sharp spine.

Fore-wing 10–14 mm. (♀ larger than ♂).

Head and mesothorax dark umber-brown or blackish, prothorax pale or ochraceous. Legs fuscous-ochraceous. Antennae dark brown. Wings umber-brown with 3–4 pale more or less hyaline spots, one distal

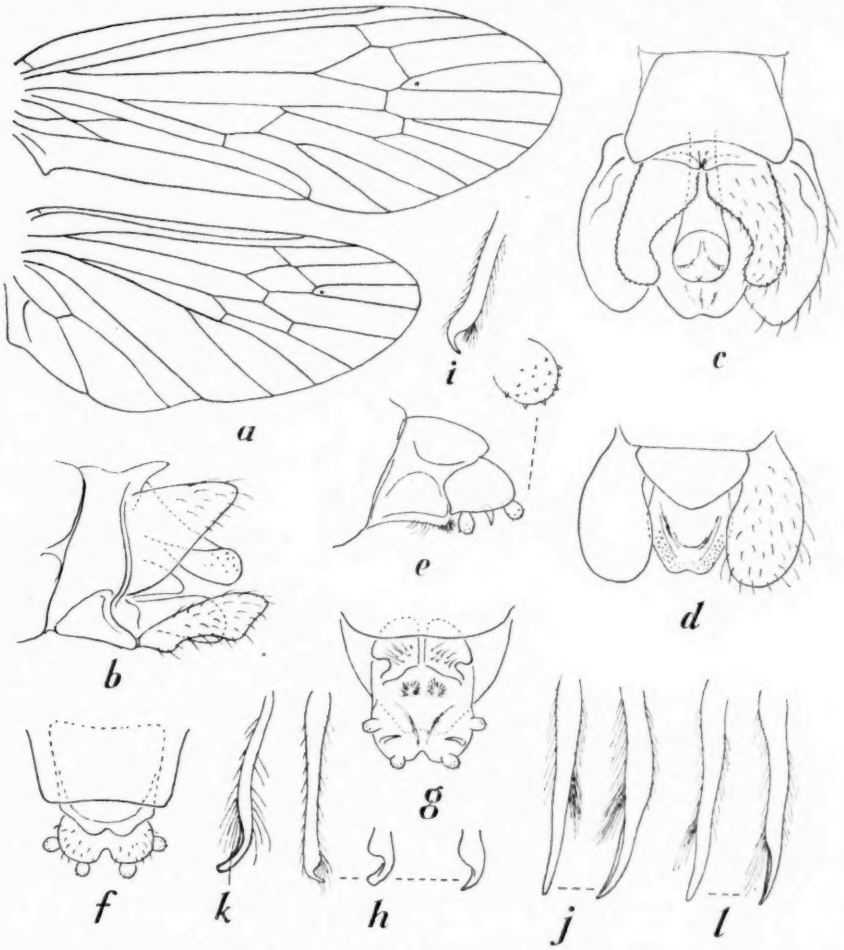

FIG. 43.—*Dipseudopsis capensis* Wlkr. *a*, fore- and hind-wings; *b*, *c*, *d*, lateral, ventral, and dorsal views ♂ genitalia; *e*, *f*, *g*, lateral, dorsal, and ventral views ♀ genitalia; *h*, inner apical spur of hind tibia ♂, with apex in two different aspects. (Specimens from Kunene River. The figures of ♂ genitalia apply also to specimen from Lake Victoria, and to *D. simplex* from Pretoria; those of the ♀ apply also to a specimen from Sierra Leone.) *i*, hind tibial spur ♂ (after Ulmer, 1929). *D. simplex* Ulmer. *j*, two views hind tibial spur ♂ (after Ulmer, 1929); *k*, spur of ♂ from Bas Ogoué (after Lestage, 1922). *D. sicumbana* Ulmer. *l*, two views hind tibial spur ♂ (after Ulmer, 1931).

to discoidal cell, one on cross-vein of thyridial cell, and 1–2 in apical cells 5 and 7. The spot distal to discoidal cell and that in cell 7 may be joined up so that a continuous pale or hyaline cross-band occurs. ♀ paler than ♂.

Localities.—Durban (Walker, Port Natal); Old Livingstone (Ulmer); Sawmills, Bulawayo, S. Rhodesia (S.A. Mus.); Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, ♂♂, ♀♀); Ponte do Pungwe, near Beira, Portuguese East Africa (Mosely).

Distribution.—Tropical West and East Africa from Abyssinia to Mozambique.

Remarks.—In the Kunene River specimens the spur resembles Ulmer's fig. 72 *a* (1905), which is typical of Brauer's Senegal specimen (type of *fasciata*). Ulmer (1929) regards *fasciata* as synonymous with *capensis*, but there seems to be just as much, or as little, difference between the spurs of these two forms as there is between the spurs of *simplex* and *sicumbana* (v. *infra*).

Dipseudopsis simplex Ulmer.

(Fig. 43 *j*, *k*.)

Ulmer, 1905A, p. 95, fig. 72 *d* (*Dipseudopsis* sp.); 1906, p. 85, figs. 87, 88; 1907, p. 188; 1929, p. 193, fig. 32. Lestage, 1919A, pp. 280, 330; 1922, p. 212, fig.

Imago.—Inner apical spur of hind tibia ♂ about half as long again as outer spur, slender, nearly evenly tapering, the apical portion darker than basal portion, and slightly hollowed on inner surface, not quite as long as the basal portion, from which it is separated by a fine (often obscure) line of demarcation. Fore-wing with fork 1 absent.

Genitalia ♂ as in *capensis*.

Fore-wing 10–13 mm.

Coloration as in *capensis*, in the Pretoria example the thyridial hyaline mark distinct, but the other hyaline spots very obscure.

Localities.—Bloemfontein and Bothaville, O.F.S. (Ulmer); Transkei (Ulmer); Pietermaritzburg, Natal (Ulmer); Pretoria (coll. Distant, ex-Brit. Mus.); Louis Trichardt, Transvaal (R. F. Lawrence, January and February 1928, ♀); Hottentots Holland Mts., Cape (K. H. B., 1917).

Distribution.—Belgian Congo (Lestage). Bas Ogoué (Ulmer).

Remarks.—The single Cape record of this species was open to a certain amount of doubt, but now seems to be confirmed by the discovery of the Polycentropodid larva described below.

Dipseudopsis sicumbana Ulmer.

(Fig. 43 *l*.)

Ulmer, 1931, p. 6, fig. 5; Mosely, 1932D, p. 5.

Imago.—Resembling *simplex*, but the apical portion of the spur only about $\frac{1}{3}$ of total length.

Localities.—Sicumbana, Delagoa Bay, Portuguese East Africa (Ulmer); Tambara and Chemba, Zambesi; and Ponte do Pungwe, Pungwe River, Portuguese East Africa (Mosely).

Remarks.—Appears to be scarcely worthy of specific rank, especially if *fasciata* be regarded as merely a form of *capensis* (v. *supra*).

Larva provisionally assigned to *Dipseudopsis*.

(Fig. 44.)

Head elongate. Mouth-parts, *cf.* Ulmer (1909A, p. 228, fig. 353) and Lestage (1921, fig. 157). Apparently no incurved spines on front margin of labrum. Only the pronotum corneous. No prosternal spine. Legs subequal; front coxa not unusually short, plaque d'appui spiniform; tibiae with two slender apical spine-setae; fore tarsus with inner margin finely spinulose (*cf.* Ulmer, 1912, fig. 45 *a*); mid and hind tarsi with row of fine spines distally overlapping base of claw; claws slender, slightly curved, with slender spine inserted a little before middle of margin. Gills and lateral line absent, but five anal gills present. Anal holdfasts elongate, 3-jointed, only the claw chitinised, strongly curved, with a comb of spines on inner margin.

Head and prothorax amber-brown, the former with paler spots on sides, the latter with narrow black hind margin, legs paler, abdomen pale emerald-green with whitish irregular lines along sides, fading in alcohol to dull mauve or pink.

Localities.—French Hoek Mts. (K. H. B., December 1932, one specimen about 13 mm. in length); Fouche's Hoek near Breede River Station (K. H. B., April 1933, one specimen 11 mm. in length).

The latter locality is a tributary of the Breede River, the former a tributary of the River Zonder End, which eventually joins the Breede River.

Remarks.—This larva belongs to the family *Polycentropidae*, and as only the genus *Dipseudopsis* is known from South Africa it may with some confidence be assigned here. Its discovery in the Cape confirms the single record of an imago which might previously have been open to doubt.

It is a more typical Polycentropid larva than the Central African one assigned to *Dipseudopsis* by Ulmer (1912, p. 117), which has an unusually short fore coxa and shorter claws on the legs and anal holdfasts.

Family Psychomyidae.

Ulmer, 1907, p. 191. Lestage, 1919A, p. 283; 1921, p. 510 (larva and pupa). Mosely, 1931, p. 547.

Imago.—Tibial spurs 2, 4, 4 or 3, 4, 4. Mid leg ♀ often dilated. Antennae not longer than fore-wing. Ocelli absent. Maxillary palp 5-jointed ♂♀, 1st joint very short, 2nd longer, 5th flexible, segmented. Labial palp 3rd joint segmented. Fore-wing with either all five forks or fork 1 absent, forks 1 (if present), 3, 4 5 stalked. Discoidal and median cells closed. Hind-wing with discoidal cell open, forks 2 and 5 or 2, 3, 5.

Genitalia ♂, preanal appendages well developed, claspers 1- or 2-jointed; ♀ often with ovipositor.

Egg-mass cemented to objects under water (Ulmer, 1909A, p. 205).

Larva.—Campodeiform. Head depressed. Antennae rudimentary. Left mandible with two cutting edges and internal tuft, right mandible with only one edge, no tuft. Maxillary palp 5-jointed. Labial lobe simple (*Ecnominae*) or produced in a long slender process (*Psychomyinae*). All three thoracic segments (*Ecnominae*) or only the pronotum (*Psychomyinae*) corneous. No prosternal spine. Legs short, subequal, claws long (*Ecnominae*) or short and stout (*Psychomyinae*). Lateral line and gills absent. Five anal gills. Anal appendages long.

No definite case, living in long winding galleries formed of sand-grains on stones, or sometimes in the canals of fresh-water sponges.

Pupa.—Fusiform. Tibial spurs 2, 4, 4 or 3, 4, 4. Antennae shorter than body. Mouth-parts terminal. Labrum short and broad. Mandibles either short with broad basis, abruptly narrowed (*Ecnominae*), or elongate, tapering to a fine often serrate apex (*Psychomyinae*). Gills absent. Terminal segment with two short appendages (*Ecnominae*), or produced in a long bilobed process (*Psychomyinae*).

Case composed of sand-grains cemented to rocks.

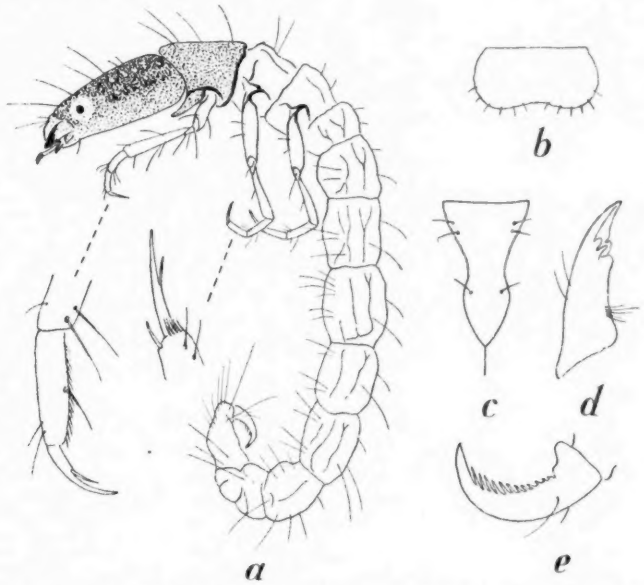

Fig. 44.—Larva assigned provisionally to *Dipseudopsis*. *a*, larva, with tarsi of fore and middle legs further enlarged; *b*, labrum; *c*, clypeus; *d*, left mandible; *e*, claw of anal holdfast.

Remarks.—Ulmer (1912) included in this family the *Ecnominae*, formerly regarded as a subfamily of the *Polycentropidae*. Lestage (1921) suggests that the *Ecnominae* should be raised to family rank.

The species inhabit either slowly running streams or lakes (*Ecnominae*), or mountain streams (*Psychomyinae*).

Subfamily Psychomyinae.

Represented in Africa by *Tinodes algerica* McLach. (Algiers), *Tinodes? annulata* Navas (Belgian Congo), *Psychomyiodes africana* Ulmer (Cameroon), and some larvae (Ulmer, 1912, p. 118) from Ruanda.

Subfamily Ecnominae.

Gen. *Ecnomus* McLach.

Ulmer, 1907, p. 190; 1931, pp. 11, 12; Lestage, 1919a, p. 284; 1921, p. 511 (larva and pupa). Mosely, 1932b, pp. 1 *sqq.* (and Stylops, vol. i, pt. 7, p. 165, 1932).

Imago.—Tibial spurs 3, 4, 4 or 2, 4, 4. Mid leg ♀ dilated. Antennae rather thick. Fore-wing with forks 1, 2, 3, 4, 5, forks 1, 3, 5 with long stalks; discoidal cell small, median cell very large, extending beyond the discoidal cell both proximally and distally; thyridial cell long. Hind-wing with forks 2 and 5.

Genitalia ♂, preanal appendages (Ulmer) or superior appendages (Mosely) long and stout.

Larva.—Pro-, meso-, and metanotum corneous. Labial lobe simple. Claws long, with setiform spine at base.

Pupa.—Tibial spurs 3, 4, 4 (as far as known). Mandibles short and broad. Terminal appendages short. Presegmental plates on segments 3–8 absent, in their place a transverse series of crotchets; on segment 5 a postsegmental transverse series of spines.

Remarks.—The genus is distributed over Europe, Asia, East Indies, Australia, and Africa. The species are very closely allied and are scarcely distinguishable except by the ♂ genitalia. Nearly all species have a speckled or chequered pattern on the fore-wings.

The appendages which Ulmer identifies as the preanal appendages and Mosely calls superior appendages would seem to be really the lobes of the 10th tergite. The tergite and sternite which Mosely attributes to the 10th segment surely belong to the 9th. In *forcipatus* and *atratus* Mosely figures two small dorso-lateral appendages between the 9th tergite and the superior appendages; these might more properly be interpreted as the preanal appendages.

Key to the South African species.

1. Tibial spurs 3, 4, 4. Claspers ♂ not abruptly narrowed apically.
   a. ♂ with titillators . . . . . *similis.*
   b. ♂ without titillators . . . . . *oppidanus.*
2. Tibial spurs 2, 4, 4. Claspers ♂ abruptly narrowed distally.
   a. Penis apically bifid . . . . . *kunenensis, natalensis.*
   b. Penis apically simple (merely excised) . . . . . *thomasseti.*

Ecnomus similis Mosely.

(Fig. 45 *e, f.*)

Mosely, 1932B, p. 12, figs. 29–31.

Imago.—Tibial spurs 3, 4, 4.

Genitalia ♂, distal margin of 9th tergite straight, lobes of 10th tergite with dorsal margin in lateral view indented, apex bluntly rounded-truncate; two ovate setose processes depending from lower surface of 10th tergite (or junction of 9th and 10th) (=Mosely: upper penis cover); penis apically tapering to a fine point; two curved spiniform titillators; clasper somewhat elongate-pyriform in lateral view, not abruptly narrowed.

Fore-wing 4 mm.

Fore-wing with pale yellow irrorations on a greyish-brown ground.

Locality.—Ceres, Cape (Mosely).

Ecnomus oppidanus n. sp.

(Fig. 45 *a–d.*)

Imago.—Tibial spurs 3, 4, 4.

Genitalia ♂, distal margin of 9th tergite with slight median notch between the two lobes of the 10th tergite, which are nearly regularly oval, slightly turned outwards; two ovate processes on under surface of 9th and 10th tergite bearing stout spines on their upper and lower margins and a rather long apical spine-seta; penis divided into an upper portion which is apically bifid, and a lower portion which ends in a fine point; no curved titillators; clasper oval, stout, not contracted, in ventral view slightly turned outwards.

Fore-wing 5 mm.

Ochraceous, fore-wing with obscure pale spots and chequers.

Locality.—"Cape Town 1885."

Remarks.—Two very old and mildewed specimens in the S.A. Museum collection are so labelled. It would perhaps be advisable to accept the locality with caution until further specimens come to hand.

Ecnomus natalensis Ulmer.

(Fig. 45 *g–i.*)

Ulmer, 1912, p. 91, fig. 16 (*deceptor* part, non McLach., not figs. 15 and 17); 1931, p. 11, p. 12, fig. 10. Mosely, 1932B, p. 15, figs. 40–42.

Imago.—Tibial spurs 2, 4, 4.

Genitalia ♂, lobes of 10th tergite oval, stout; penis ending in two upturned points; two pairs of curved titillators; clasper abruptly narrowed in ventral and lateral views, apical portion incurved. ♀ (labelled paratype, Weenen, ex-Brit. Mus.), terminal segment bifid, in lateral view short, subtruncate; subgenital plate deeply cleft, lobes divergent, apically subacute.

Fore-wing 5 mm.

Locality.—Weenen, Natal (Ulmer).

Distribution.—Lake Kivu (Ulmer).

Remarks.—Two ♀♀ from Kaapmuiden, Transvaal (R. W. E. Tucker, November 1918), and one from Pietermaritzburg, Natal, differ from the above in having the bifid terminal segment much longer in lateral view, and the subgenital plate of different shapes (fig. 45 *j–l*, and *n*). Distinct species seem to be indicated, but ♀♀ cannot be definitely assigned in the absence of ♂♂. In fact they should never be assigned unless actually caught *in copula*.

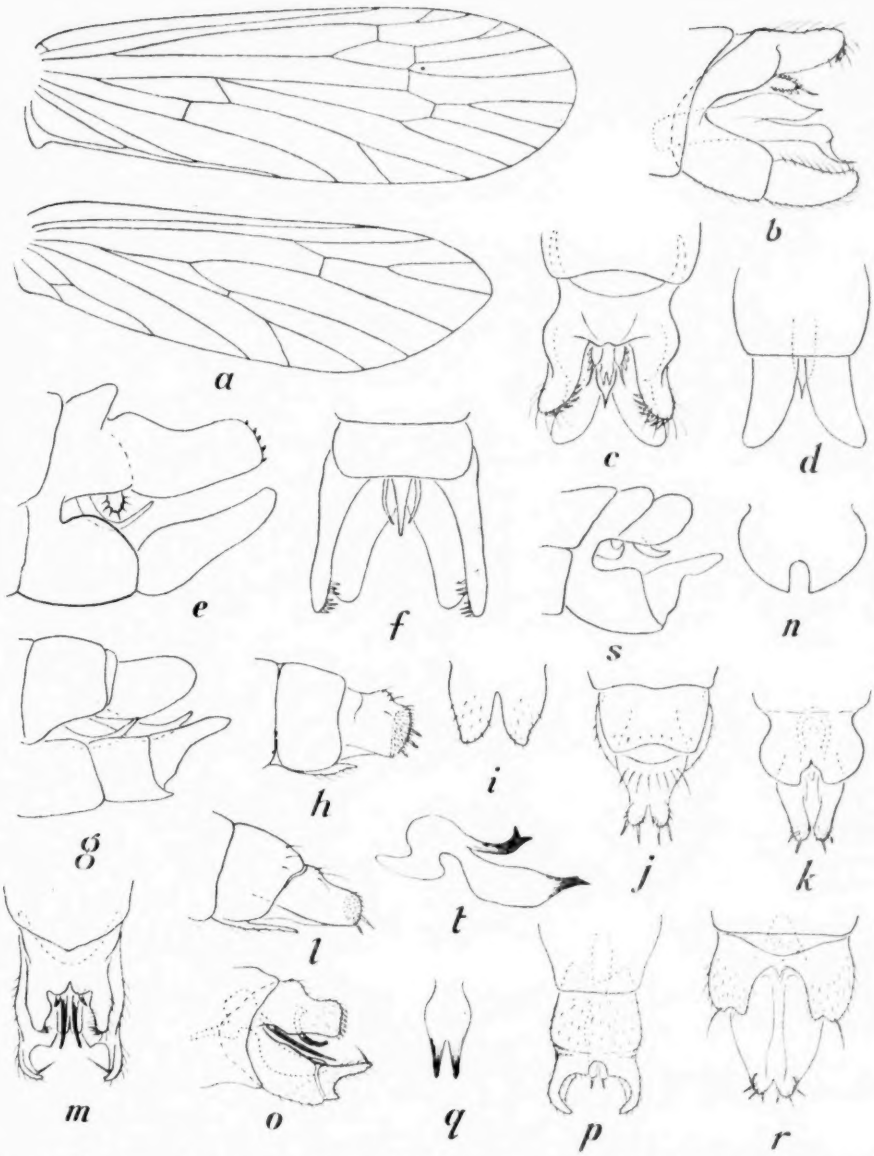

FIG. 45.—*Ecnomus oppidanus* n. sp. *a*, fore- and hind-wings; *b*, *c*, *d*, lateral, dorsal, and ventral views genitalia ♂. *E. similis* Mosely. *e*, *f*, lateral and dorsal views genitalia ♂ (after Mosely). *E. natalensis* Ulmer. *g*, lateral view genitalia ♂ (after Ulmer); *h*, lateral view genitalia ♀ (paratype, Weenen, ex-Brit. Mus.); *i*, subgenital plate of same. *E. natalensis*? *j*, *k*, *l*, dorsal, ventral, and lateral views genitalia ♀ from Kaapmuiden. *E. natalensis*? *n*, subgenital plate ♀ from Pietermaritzburg. *E. kunenensis* n. sp. *m*, *o*, *p*, dorsal, lateral, and ventral views genitalia ♂; *q*, dorsal view of apex of penis; *r*, ventral view genitalia ♀. *E. thomasseti* Mosely. *s*, lateral view genitalia ♂ (after Mosely). *E. thomassati*? *t*, lateral view of penis of specimen from Kunene River.

One of the pairs of curved titillators (see Ulmer's figure) is apparently homologous with the ovate processes found in *similis* and *oppidanus*. Ulmer's description of the claspers as being 2-jointed does not seem to be correct.

Ecnomus kunenensis n. sp.

(Fig. 45 *m*, *o–r*.)

Imago.—Genitalia ♂, 9th tergite with median notch, lobes of 10th tergite short, in lateral view with concave upper margin, apically truncate; a pair of curved spiniform processes depending from 9th–10th tergite; a pair of elongate spiniform titillators from base of penis, which is apically bifid; apex of claspers with one long slender seta; ♀ similar to *natalensis* but shape of subgenital plate different, being divided into widely separated plates; the bifid apex of abdomen in lateral view as in the Kaapmuiden specimen.

Fore-wing 5 mm.

Head and thorax fulvous-brown, with golden-brown hairs. Legs ochraceous, tarsi annulate, especially the fore tarsi. Antennae ochraceous, with fulvous or brown annulations. Wing membrane pale grey, with slightly darker neuration; speckled with white and sepia-brown hairs, the white forming numerous more or less conspicuous roundish dots on the grey ground colour, apical margin with alternate white and brown spots.

Locality.—Kunene River, South West Africa (K. H. B. and R. F. Lawrence, March 1923, ♂♂, ♀♀).

Remarks.—Differs from *natalenis* in the truncate lobes of 10th tergite in ♂, and the subgenital plates in ♀.

Ecnomus thomasseti Mosely.

(Fig. 45 *s*.)

Mosely, 1932B, p. 15, figs. 43–45, and 1932D, p. 5.

Imago.—Tibial spurs 2, 4, 4. Hind-wing slightly narrower than in *natalensis*.

Genitalia ♂ very like those of *natalensis*. Two small uncinate upturned processes at base of penis; two gently curved spiniform processes depending from 9th–10th tergite; penis apically entire, though excised dorsally and ventrally.

Fore-wing 4 mm.

Localities.—Weenen, Natal (Mosely); Chamba, Zambesi, and Ponte do Pungwe, Pungwe River, Portuguese East Africa (Mosely).

Remarks.—Only to be distinguished from *natalensis* by the short uncinate processes at base of penis. Even this may not prove constant when more specimens are examined. One of the Kunene River specimens mentioned above may be this species, as it has the spinous process on the dorsal side of the penis shorter and apically bifid, and the apex of the penis acute and more strongly chitinised (fig. 45 *t*).

Fam. *Philopotamidae*.

Ulmer, 1907, p. 195. Lestage, 1919A, p. 261; 1921, p. 464 (larvae and pupae).

Imago.—Tibial spurs 2, 4, 4, sometimes 1, 4, 4 or 0, 4, 4. Middle leg of ♀ often expanded. Antennae strong, about as long as fore-wing, 1st joint not much thicker than following joints. Ocelli present. Maxillary palp with 1st joint, and sometimes 2nd also, short or very short, 4th shorter than 3rd, 5th (♂ and ♀) elongate, segmented, apex of 2nd joint with a tuft of setae. Wings more or less elongate oval; costal area with additional cross-vein; apical forks 1, 2, 3, 4, 5 or 1, 2, 3, 5 in fore-wing present, discoidal and median cells closed or open; hind-wing as broad or broader than fore-wing, usually with apical forks 1, 2, 3, 5; discoidal cell closed, median cell usually open. ♀ sometimes with long ovipositor.

Egg-mass.—Cemented to stones under water (Ulmer, 1909A, p. 205).

Larva.—Campodeiform. Head elongate oval; labrum soft, not chitinised, pale, retractile, dilated in front; mandibles stout, denticulate. Maxillary palp 4-jointed. Labial palp rudimentary. Prothorax chitinised, meso- and metathorax membranous; no prosternal spine. Legs subequal. Anal appendages strong, 2-jointed, claws simple, strong. Lateral line and abdominal gills absent; 4–5 anal gills.

Living in a loosely constructed network of silken threads. Sometimes several larvae live together in small colonies.

Pupa.—Labrum semi-circular. Mandibles long, strong, more or less geniculate at base, inner margin toothed and finely serrulate. Middle tarsus with notatory fringe. Lateral line and gills absent. Abdomen with presegmental dorsal plates on segments 3–7 or 3–8, and also postsegmental on segment 5. Anal segment of ♂ more or less the shape of the enclosed genital appendages, of ♀ bluntly conical. Enclosed in a thin transparent imperforate silken cocoon within a case of small stones or sand-grains cemented to rocks.

Remarks.—Two genera are known from Africa, of which one occurs in South Africa. A new genus, allied to *Dolophilus*, is described below. The family is characteristic of mountain streams.

Stenopsyche and its allies form a separate family, *Stenopsychidae*.

Key to the African genera.

1. Fore-wing with apical forks 1, 2, 3, 5.
   a. Maxillary palp with 2nd joint much longer than 1st. Tibial spurs 1, 4, 4 or 0, 4, 4 . *Chimarrha*.
   b. Maxillary palp with 2nd joint as long as 1st. Tibial spurs 2, 4, 4 . . . *Wormaldia*.
2. Fore-wing with apical forks 1, 2, 3, 4, 5. Tibial spurs 2, 4, 4 . . . . . *Thylakion*.

Gen. *Chimarrha* Burm.*

Ulmer, 1907, p. 199; 1913, p. 189; 1930, p. 479 and p. 501 (larva); 1931, pp. 2, 3, 4. Lestage, 1919A, pp. 261 *sqq.*

Imago.—Tibial spurs 1, 4, 4 or 0, 4, 4; spur on front tibia, if present, short. Middle leg of ♀ scarcely broadened. Front tarsus in ♂ (usually) stouter and the claws larger than in ♀, the outer claw slightly larger than inner claw. Antennae scarcely as long as fore-wing, widely separated at base, basal joint stout. Maxillary palp strong, 2nd and 3rd joints long, 2nd with well-marked apical tuft of setae. Apical forks 1, 2, 3, 5 in both wings, 3 with long stalk. Usually a naked space in fore-wing between the discoidal and median cells. Thyridial cell in fore-wing longer than median cell. Genitalia in ♂ variable; ♀ without ovipositor.

Larva.—Maxillary palp straight. Anal gills 5.

Pupa.—Mandibles stouter than in *Wormaldia*, with a single bifid tooth on inner margin. Abdominal segments 3–8 with presegmental plates. Middle tibia fringed.

Remarks.—The hitherto known African species are: *minima* Ulm., 1907, and *togoana* (Ulm.), 1907, from Togoland †; *fallax* (Ulm.), 1912 from Cameroons †; *abyssinica* Banks, 1913, from Abyssinia; *africana* Ulm., 1929, and *kenyana* Ulm., 1931, from East Africa; *lacroixi* Navas, 1921, from Madagascar; and *ruficeps* Ulm., 1913, from Zululand.

A larva referred to this genus has been briefly mentioned by Ulmer (1912, p. 116), the only features mentioned being the asymmetrical anterior margin of head and the plaque d'appui of the fore leg. In 1930 (p. 501) the same author says the larva looks like a European *Philopotamus* larva.

The pupa has not hitherto been described.

Key to the South African species.

1. In hind-wing R_1 distinct and complete. Anastomosis gradated.
   a. Rs in fore-wing arising distal to proximal end of thyridial cell.
      i. Head and thorax golden-red. Fore-wing 10 mm. ♂ with long process on 9th sternite . *ruficeps.*
      ii. Head yellowish, thorax piceous, both with black hairs. Fore-wing 5–7 mm. ♂ without process on 9th sternite . . . . . *ambulans.*
   b. Rs arising at same level as proximal end of thyridial cell. ♂ with short process on 9th sternite. *ceceris.*
2. In hind-wing R_1 incomplete, becoming obsolete just beyond origin of Rs. Anastomosis almost straight and transverse . . . . . *georgensis.*

Chimarrha ruficeps Ulm.

(Fig. 46.)

Ulmer, 1913, p. 189, fig. (venation).

Imago.—Tibial spurs 1, 4, 4. In fore-wing R strongly bent both before and after its junction with Rs, which arises distal to origin of the curved thyridial cell. Discoidal cell broad. Median cell as long as discoidal,

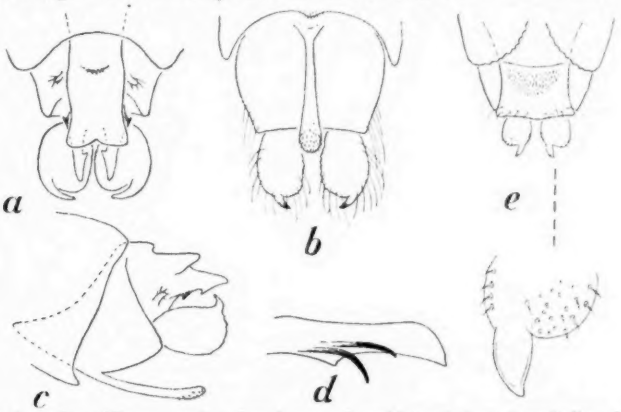

FIG. 46.—*Chimarrha ruficeps* Ulmer. *a*, *b*, *c*, dorsal, ventral, and lateral views ♂ genitalia; *d*, penis; *e*, dorsal view ♀ genitalia, with apical papilla further enlarged.

* 1815, *Chimarra* Leach, Ed. Enc., vol. ix, p. 136, 1830 (nom. nud.); 1829, *Chimarra* Stephens, Cat. Brit. Ins., p. 318; 1839, *Chimarrha* Burmeister, Hand. Ent., vol. ii, pp. 903, 910; 1859, *Chimarcha* Kolenati, N. Mem. Soc. Mosc., vol. xi, p. 145.

† Originally placed in *Wormaldia*, but Ulmer in 1931 (*loc. cit.*, p. 3) says these two species are better placed in *Chimarrha*.

its distal cross-vein only slightly proximal to cross-vein between R_{4+5} and M_{1+2}. Naked spot distinct. Fork 1 sessile, fork 2 very shortly stalked.

Genitalia ♂, 8th sternite with short median projection; 9th sternite with long, narrow, apically somewhat clavate process; fused 9th and 10th tergites with basal median boss, apically truncate and slightly incised; below the apex two vertical ovate processes with a minute hook ventrally; laterally a small recurved strongly chitinised hook just in front of the conical setose tubercle (preanal appendage); clasper broadly ovate, with a strong incurved hook arising from upper apical margin; penis with two blackish spiniform titillators. ♀ dorsal plate with large semi-circular patch of minute setules; apical (membranous) processes broadly ovate, the terminal appendage slightly more strongly chitinised, apically subacute; subgenital plate undivided.

Fore-wing 10 mm.

Head and thorax orange-red with golden hairs, metanotum dark brown. Abdomen blackish, paler at sides. Antennae and palps blackish. Femora yellowish, tibiae and tarsi brownish. Wing membrane pale brown, neuration brown.

Locality.—M'fongosi, Zululand (W. E. Jones, November, December, 1911 and 1912).

Remarks.—This species resembles *fallax* in the venation, and both *togoana* and *fallax* in having a process on the 9th sternite in the ♂. The ♂ here described was collected in 1912 and was not sent to Ulmer.

Chimarrha ambulans n. sp.

(Figs. 47 and 1 *b*.)

Imago.—Tibial spurs 1, 4, 4. Sexual difference in front tarsus very slight. In fore-wing R nearly straight, Rs gently curved, arising distal to origin of the straight thyridial cell. Discoidal cell subequal to its stalk. Median cell almost as long as discoidal cell, its distal cross-vein on a vertical from ⅔ length of discoidal cell. Fork 2 sessile.

Genitalia ♂, 9th sternite with very short median spiniform process, fused 9th and 10th tergites with wide median excavation, running out laterally into a spinous process, which may be acute or blunt, below which is a vertically set rounded lobe; clasper prominent, strongly curved, with pointed apical process; penis with dorsal and ventral pairs of chitinised denticulate plates and two spiniform titillators. ♀ dorsal plate with small median patch of minute setules, apical processes ovate, terminal appendage with minute notch, subgenital plate basally broad, apically bilobed; a slightly projecting short median ridge on 7th sternite.

Fore-wing 5–7 mm.

Head yellowish, piceous between the eyes, with dark greyish or nearly black hairs. Thorax piceous. Antennae, palps, and legs piceous. Abdomen dark sepia, paler along sides. Wing membrane greyish or brown, neuration darker, pubescence dark sepia, or in fresh specimens blackish, with the bare spots white, the spot between discoidal and thyridial cells usually conspicuous.

Larva.—Anterior margin of head slightly sinuous, with a notch which is always slightly to the right of the median line. Front femur without stout spines.

Up to 10–11 mm.

Head and pronotum deep amber, the latter rather paler and with black posterior margin. Legs pale horny, with black marks at their bases. Abdomen white or creamy.

Pupa.—Mandible moderately elongate, with subterminal bifid tooth, the inner margin minutely denticulate. Presegmental dorsal plates on segments 3–8 with 5, 5, 6, 5, 4, 4 spines respectively, postsegmental plate on segment 5 with six spines. 6–7 mm.

Localities.—Cape Peninsula (K. H. B., A. C. H., H. G. W., various dates); Hottentots Holland Mts. (K. H. B., January 1916 and November 1932); Jonkershoek, Stellenbosch (A. C. H., K. H. B., H. G. W.); Groot Drakenstein (A. C. H.); Paarl (Rev. Hawke, in S.A. Mus.); French Hoek Mts. (K. H. B., April 1931, and H. G. W., December 1932); Witte River, Wellington Mts. (K. H. B., November 1922); Gt. Winterhoek Mts. (K. H. B., September 1932, and H. G. W., November 1932); Hex River Mts. (northern slopes) (K. H. B., January 1917); Bosch Kloof, Keeromberg, Worcester (H. G. W., January 1933); Naudesberg, Worcester (K. H. B. and H. G. W., August 1932); Du Toit's Kloof, Rawsonville (K. H. B., March 1932); Cedar Mts., Clanwilliam (K. H. B., January 1930); Warm Baths, Citrusdal, Clanwilliam District (K. H. B., September 1932); Montagu (R. M. Lightfoot, October 1919); Seven Weeks Poort, Zwartberg Range, Ladismith, Cape (K. H. B. and H. G. W., February 1932); Robinson Pass, Outeniqua Range (N. of Mossel Bay) (K. H. B. and H. G. W., February 1932); River Zonder End Mts. (H. G. W., January 1933); Palmiet River (H. G. W., March, July, December 1932); stream three miles west of Kaaiman's Gat, George District (H. G. W., April 1933).

Remarks.—In the ♂ genitalia there is a resemblance to *kenyana* Ulmer, 1931, but there are no mediodorsal tubercles on the basal plate (Ulmer has possibly overlooked the lateral setose tubercles); Ulmer makes no mention of any penis armature or titillators.

The pale bare space on fore-wing is very inconspicuous in two specimens from the Gt. Winterhoek Mts.

Variation in venation of one or both wings is not infrequent. In fore-wing fork 1 may be almost obsolete, due to the approximation and partial fusion of R_2 and R_3; fork 3 may be reduced to a lenticular cell on a single vein (M_{1+2}). In hind-wing fork 2 is normally sessile, but R_4 and R_5 may fuse proximally to form a long stalk, or midway to form a lenticular cell and an apical fork. Cu_{1a} and Cu_{1b} may also unite distally, forming a lenticular cell instead of a fork. These variations are not always symmetrical on the two sides of the insect.

The median cell in hind-wing is normally open, but occasionally a very distinct cross-vein is developed, converting it into a closed cell.

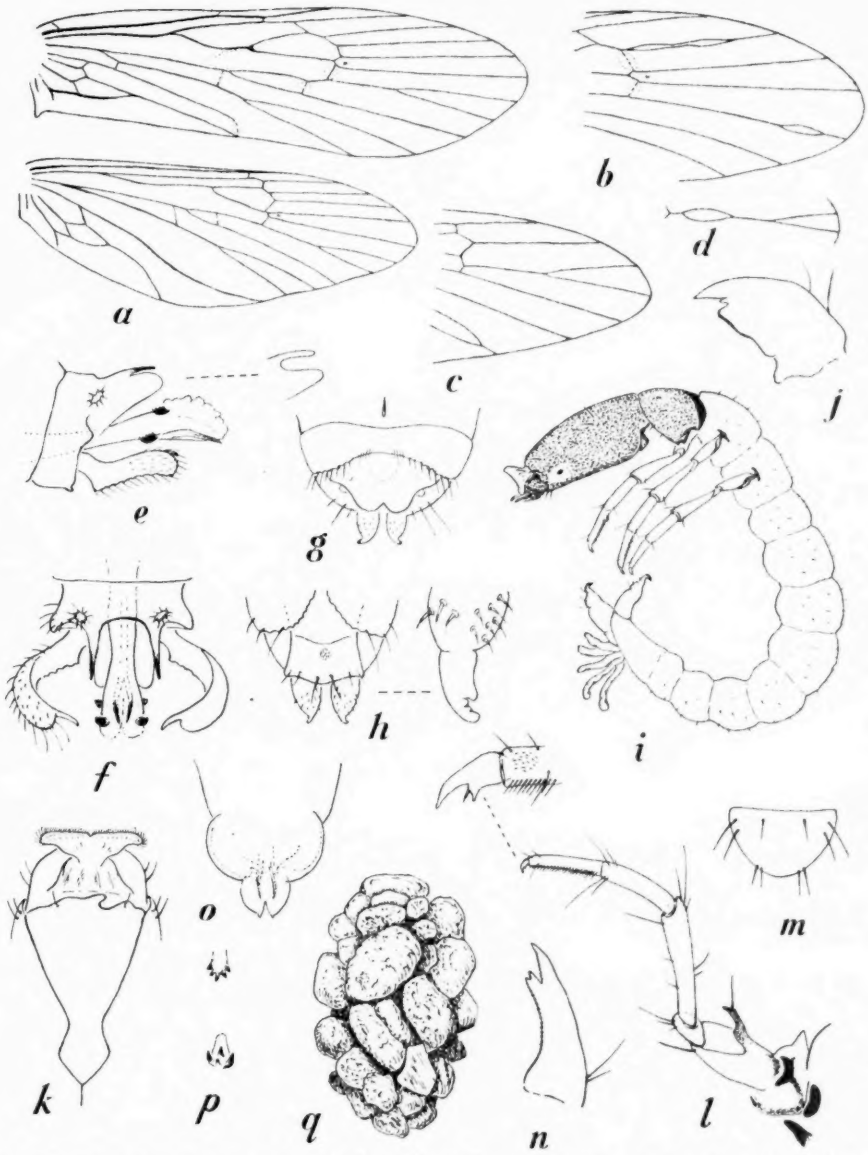

FIG. 47.—*Chimarrha ambulans* n. sp. *a*, fore- and hind-wings; *b*, variation in fore-wing; *c*, variation in hind-wing; *d*, aberrant form of fork 2 in hind-wing; *e*, *f*, lateral and dorsal views ♂ genitalia, with variation in lobe of 10th tergite; *g*, *h*, ventral and dorsal views ♀ genitalia, with apical papilla further enlarged; *i*, larva; *j*, mandible of larva; *k*, clypeus and labrum of larva; *l*, fore leg of larva; *m*, labrum of pupa; *n*, mandible of pupa; *o*, apex of abdomen of pupa (♂); *p*, dorsal plates of 5th segment of pupa; *q*, pupal case.

A ♀ from Howick, Natal, may be this species. The venation agrees closely, though the origins of Rs and the thyridial cell are nearer together, and the latter is somewhat more curved (cf. *ruficeps*).

Habits.—This is a very common species in the mountain streams of the Cape Peninsula, appearing in a succession of cycles throughout the year. It occurs at the lower levels, and does not inhabit the streams on the top of Table Mt., where its place is taken by *Thylakion urceolus* (*infra*). The flies sit about openly, and run rapidly over the rocks projecting out of the water; when disturbed and closely pursued they make short jerky flights to neighbouring rocks. The wings are folded down low over the body and partially wrapped round it (somewhat like a Stone-fly). The species is also widely distributed in the mountains of the mainland.

Chimarrha cereris n. sp.

(Fig. 48 *a–f*.)

Imago.—Tibial spurs 1, 4, 4. Sexual difference in front tarsus very slight. In fore-wing R gently sinuous. Rs bent and strongly thickened at base of discoidal cell, arising at same level as proximal end of the slightly lenticular thyridial cell. Discoidal cell (including the thickened basal part) subequal to its stalk. Median cell much shorter than both discoidal and thyridial cells, its distal cross-vein about in a straight line with origin of fork 5 and the cross-vein between R_1 and R_2. Apical fork 2 sessile. In hind-wing median cell open.

Genitalia ♂, 9th sternite with short process; 10th tergite bilobed, each lobe apically turned outwards; preanal appendages button-like; penis membranous, with a stout chitinised uncinate process (titillator) on either side; clasper spatulate, upper margin produced as a strong chitinised spiniform process, apex of ventral portion subacute, with subterminal short stout spine on upper surface.

♀ subgenital plate distinct, bifid, lobes not divergent; dorsal plate with transverse band of minute setules across the middle, and setae on distal margin; a short median ridge on 7th sternite ending in a slightly projecting, sharp point.

Fore-wing 6–6·5 mm.

Head and thorax ochraceous or fulvous with pale golden hairs. Antennae, palps, and legs ochraceous or fulvous. Wing membrane pale brown with slightly darker neuration; pubescence fawn-brown, the bare spot of same colour as rest of wing and not conspicuous.

Localities.—Ceres (R. M. Lightfoot, April 1913, ♂, ♀♀); Groot Drakenstein (A. C. H., 1931, ♀).

Remarks.—This species is easily distinguished from *ruficeps* and *ambulans* by the origin of Rs and the thyridial cell being at the same level, and the very short median cell in fore-wing.

The coloration as given above may not be quite correct for freshly caught specimens.

Chimarrha georgensis n. sp.

(Fig. 48 *g–m*.)

Imago.—Tibial spurs 1, 4, 4. Sexual difference in front tarsi well marked, the tarsus stouter in ♂ than in ♀, the claws larger, strongly falcate, and slightly unequal. In fore-wing R straight, but gently curved at the origin of Rs, which is a short distance distal to origin of the straight thyridial cell. Discoidal cell shorter than its stalk. Median cell longer than discoidal, almost as long as thyridial cell. Fork 2 sessile. Anastomosis (cross-veins R_3–R_4, R_5–M_{1+2}, M_{1+2}–M_{3+4} in a nearly straight and transverse line. Cross-veins Sc–R–R_2 very oblique. In hind-wing R becoming obsolete immediately after origin of Rs, discoidal cell consequently connected directly with Sc by a very oblique cross-vein. Median cell open.

Genitalia ♂, preanal appendages rod-like, short and feebly curved; on each side of penis (but connected therewith) a trifid process, the upper prong narrowly triangular, the middle one short and curved, the lower one elongate, strongly curved at base; penis with a pair of spinous titillators and a median less strongly chitinised process which is apically trifid, all of which are apparently eversible; on each side a heavily chitinised (black) process, curving downwards and apically widely bifid; clasper short, oblong, with a triangular projection on lower inner margin. ♀ dorsal plate smooth, apical processes ovate with the papilla subterminal (cf. *Thylakion* infra), subgenital plate deeply cleft, lobes adjacent, triangular, basal part chitinised, apex clear; a slightly projecting short median ridge on 7th sternite.

Fore-wing 6 mm.

Head and thorax (in alcohol) dark sepia-brown. Wings brown with darker neuration, the anastomosis and portions of other veins, as indicated in fig. 48 *g*, clear white. No indication of a naked spot in fore-wing.

Locality.—Stream 3 miles west of Kaaiman's Gat, George District (H. G. W., April 1933, 1 ♂, 2 ♀♀).

Remarks.—Only one ♂ was caught, and the complicated genitalia being so heavily chitinised and pigmented it was impossible to distinguish the separate parts except after dissection; complete dorsal and lateral views of the genitalia therefore cannot be given. The clear white, straight anastomosis serves at once to distinguish this species from the other South African species.

Thylakion n. g.

Imago.—Tibial spurs 2, 4, 4. Middle leg of ♀ not widened. Claws of ♂ normal. Antennae about as long as fore-wing. Maxillary palp with 1st and 2nd joints subequal, short but not very short, 2nd strongly hairy on inner margin, 3rd longer than either 1st or 2nd, 4th equal to 2nd, 5th longer than 3rd plus 4th, almost as long as 2nd and 4th together. Apical forks 1, 2, 3, 4, 5 in fore-wing, 1 and 2 sessile, 3 stalked. Median cell longer and narrower than discoidal cell, upper margin of the latter not angular. "Postcostal" (between 1A and hind margin) broad. Apical forks 1, 2, 3, 5 in hind-wing, 1 and 2 sessile.

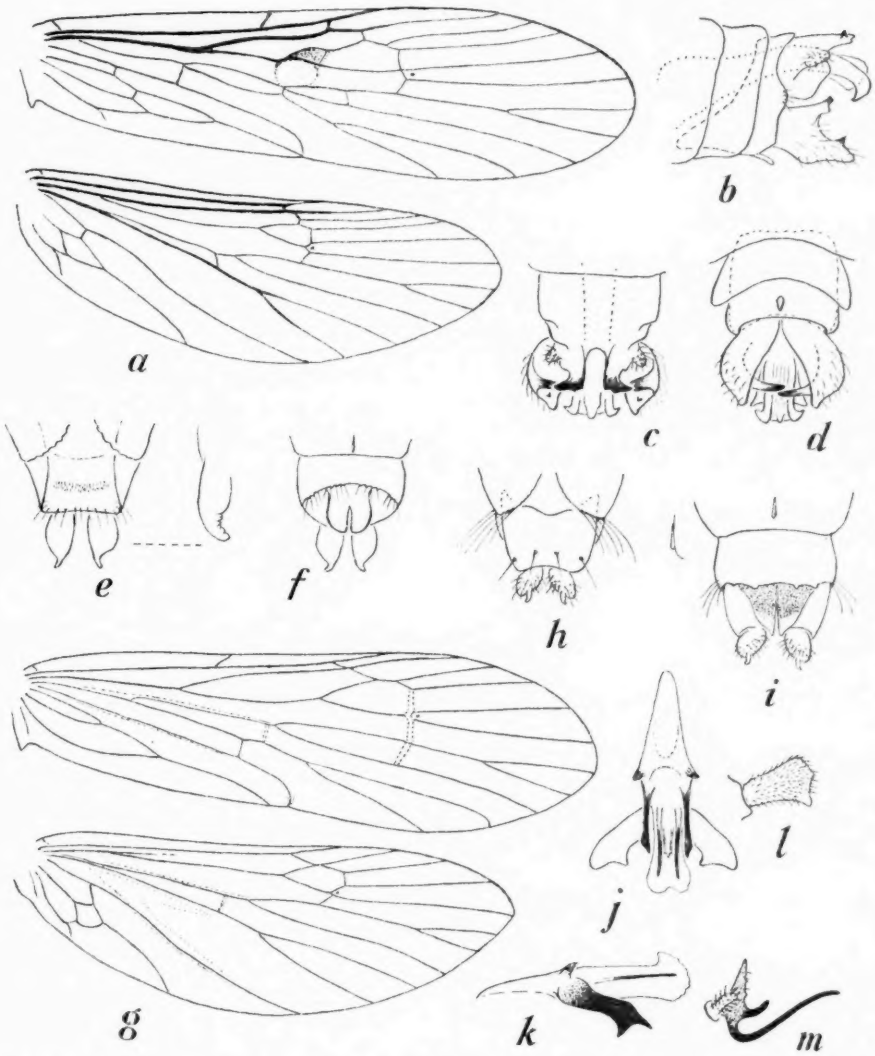

FIG. 48.—*Chimarrha cereris* n. sp. *a*, fore- and hind-wings; *b*, *c*, *d*, lateral, dorsal, and ventral views genitalia ♂; *e*, *f*, dorsal and ventral views genitalia ♀, with apical papilla further enlarged. *C. georgensis* n. sp. *g*, fore- and hind-wings; *h*, *i*, dorsal and ventral views ♀ genitalia; *j*, dorsal view of penis and claspers ♂; *k*, lateral view of penis; *l*, lateral view of clasper; *m*, lateral view of preanal appendage and trifid process. (In *c* the incurved processes are not completely drawn.)

Genitalia ♂, claspers large, 2-jointed, 2nd joint not forked, lobiform, with apical palisade-like rows of spines, penis with the apical portion eversible, armed with minute spinules. ♀ with ovipositor.

Larva.—Maxillary palps straight. Anal gills 5.

Case a silken bag, tubular or sacciform, attached to stones, rocks, moss, or dead sticks.

Pupa.—Mandibles slender, elongate, with three teeth on inner margin. Presegmental dorsal plates on segments 3–7, postsegmental also on segment 5.

Case composed of sand-grains affixed to undersurface of stones in streams.

Remarks.—Resembling *Philopotamus* in the shape of the discoidal cell, but the nearly straight anastomosis (cross-veins between R_3 and M_{3+4}) is like that of *Dolophilus*, and the genitalia of both sexes are of the *Dolophilus* type.

Genotype: *T. urceolus* n. sp.

Thylakion urceolus n. sp.

(Fig. 49 *a–j*.)

Imago.—Genitalia ♂, 7th sternite with slight triangular median point (but not spiniform or projecting), 9th and 10th tergites fused, the latter lanceolate, elongate, with two pairs of processes, the first long, slender, arising near base, twisted distally and ending in a fine mobile spine, the second shorter, arising about midway; preanal appendages narrow lanceolate; penis simple, with a pair of very slender titillators on lower surface; clasper stout, basal joint with stout recurved spine on inner surface, 2nd joint obovate, apically truncate, with four rows of black spines close-set like palisades. ♀ ovipositor elongate, with a pair of apical tactile processes.

Fore-wing ♂ 5·5–6 mm., ♀ 6–6·5 mm.

Head and thorax fuscous with black hairs. Head darker between the glistening white ocelli. Antennae pale fuscous, obscurely annulate. Legs pale fulvous. Wing membrane by reflected light brown with darker venation; in fore-wing pterostigmal area lighter, somewhat milky; a straight transverse stripe along the anastomosis, and a T-shaped mark at junction of M_{1+2} and M_{3+4} and cross-vein to Cu_1 and also apex of Cu_2 white; by transmitted light pterostigmal area is semiopaque, and the three marks are clear, the veins composing the anastomosis faint.

Larva.—Anterior margin of head convex, slightly and irregularly crenulate. Mandibles like those of *C. ambulans* (fig. 47 *j*). Anal gills 5. Femur of fore leg with a row of black spines on lower outer margin. Up to 12 mm.

Head and pronotum light amber or ochraceous, the latter paler and with black posterior margin. Legs pale horny, with black marks at bases. Abdomen nearly colourless in life, whitish in alcohol.

Case a silken bag, 1–2 inches long, attached to stones, moss, etc., in situations where there is a continuous flow of water.

Pupa.—Mandibles with three strong teeth in addition to the apical one, inner margin minutely denticulate. Presegmental dorsal plates with 6–8 spines on segments 3–5 and 7, twelve spines on segment 6, postsegmental plate on segment 5 with six spines. 9–10 mm. Abdomen yellowish or orange.

Localities.—Table Mt. (K. H. B., April, October, December 1932, February 1933); Hottentots Holland Mts. (K. H. B. and H. G. W., November 1932 and January 1933); French Hoek Mts. (K. H. B. and H. G. W., December 1932); Bain's Kloof, Wellington Mts. (K. H. B. and H. G. W., 1st May 1933, ♀); Robinson Pass (N. of Mossel Bay), Outeniqua Range (K. H. B. and H. G. W., February 1932); Montagu Pass, N. of George, Outeniqua Range (H. G. W., April 1933, ♂♂, ♀♀, larvae).

Remarks.—This species is found in the upper parts of swiftly flowing streams on Table Mt., and does not overlap with *C. ambulans*, which is found at lower levels. In the head waters of the Palmiet River (east of the Spitzkop, in the Hottentots Holland Mts.) the two species intermingle, but the habits of the flies are quite different. The flies of *T. urceolus* do not run about openly as do those of *C. ambulans*, but are usually found on the undersides of stones projecting in mid-stream, or shady corners where two rocks lean up against one another. Their wings are held at a steep angle, roof-wise, over the body.

The mouths of the larval cases are directed up-stream, and the current keeps the bags distended. Fine vegetable detritus collects on the outside, and the bags look like slimy, muddy algal growths. Several are often found in juxtaposition and inextricably mixed, so that when a mass is removed from the water several larvae appear to come out of one case.

Thylakion forcipatum n. sp.

(Fig. 49 *k–m*.)

Imago.—Venation as in *urceolus*. Genitalia ♂, also similar, but the 10th tergite without the short second pair of processes, and the claspers very elongate, their basal joint without the spine on inner surface. ♀ as in *urceolus*.

Fore-wing ♂ 6 mm., ♀ 6·5–7 mm.

Colour apparently similar to that of *urceolus* (all specimens in alcohol).

Larva and pupa and pupal case like those of *urceolus*.

Locality.—River Zonder End Mts. (K. H. B., December 1920, and H. G. W., January 1933, larvae, pupae, ♂♂, ♀♀).

Remarks.—Apparently a more local species than *urceolus*, easily distinguished in the ♂ sex by the elongate claspers.

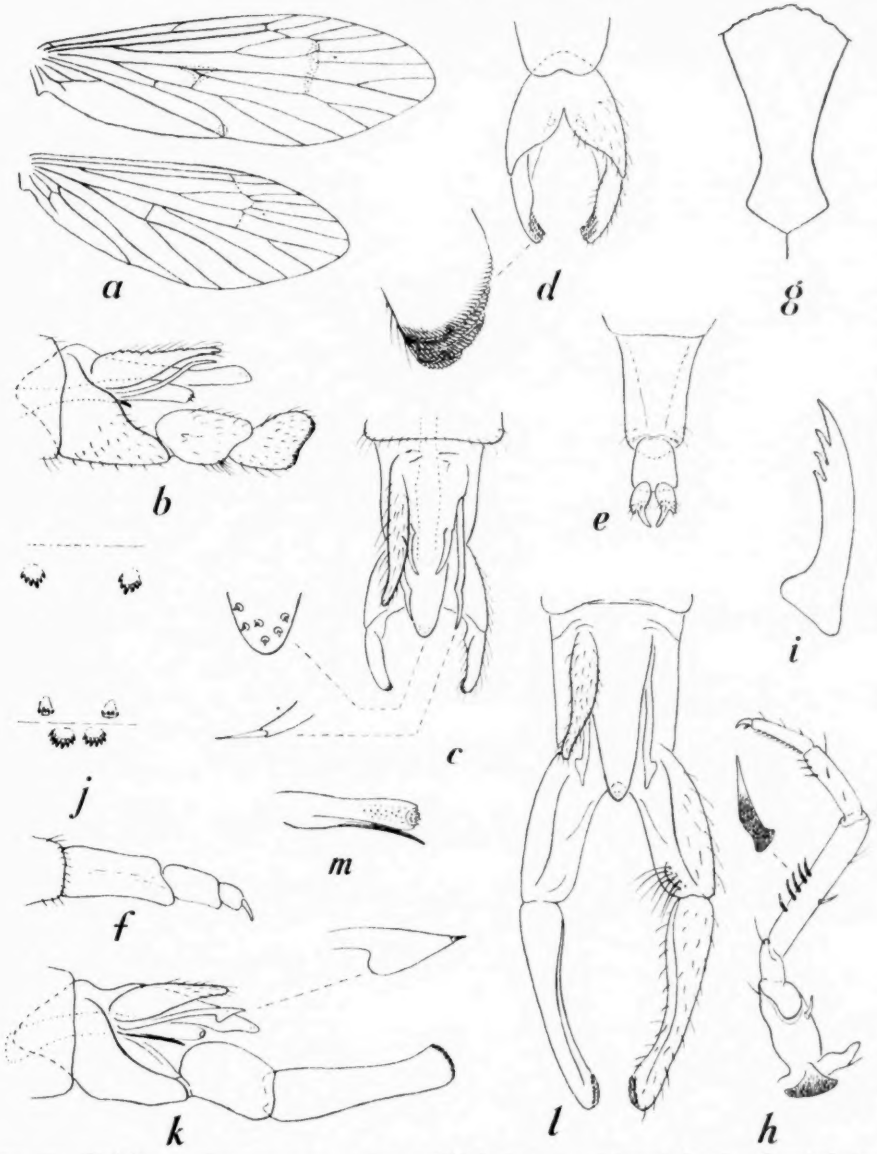

FIG. 49.—*Thylakion urceolus* n. g., n. sp. *a*, fore- and hind-wings; *b*, *c*, *d*, lateral, dorsal, and ventral views ♂ genitalia, with apices of 10th tergite, process of latter, and clasper further enlarged; *e*, *f*, dorsal and lateral views ♀ genitalia; *g*, clypeus of larva; *h*, fore leg of larva, with femoral spine further enlarged; *i*, mandible of pupa; *j*, dorsal plates of 5th (pre- and postsegmental) and 6th (presegmental) segments of pupa. *T. forcipatum* n. sp. *k*, *l*, lateral and dorsal views ♂ genitalia with apex of process of 10th tergite further enlarged; *m*, penis. (In *c* and *l* the right preanal appendage removed.)

Family Rhyacophilidae.

Ulmer, 1907, p. 202; Lestage, 1921, p. 410 (larva and pupa).

Imago.—Tibial spurs 3, 4, 4 or 2, 4, 4. Antennae about as long as fore-wing, basal joint stout. Ocelli present. Maxillary palp 5-jointed ♂ ♀, first two joints short, 5th not segmented, usually not flexible. Wings rather elongate. Discoidal cell in both wings either closed or open, or often wanting in hind-wing. Fore-wing with forks 1, 2, 3, 4, 5 (one exception); thyridial cell present, median cell seldom present. Additional costal cross-vein sometimes present. In hind-wing at least forks 2 and 5 present. Abdomen of ♂, seldom also ♀, often with spiniform or dentiform ventral processes. ♀ with two terminal cerci.

Egg-mass.—Cemented to stones under water (Ulmer, 1909a, p. 204).

Larva.—Campodeiform. Antennae rudimentary. Labrum chitinised. Pronotum corneous, meso- and metanotum either membranous or each with two chitinous plates. No prosternal spine. Legs subequal, claws strong, with stout basal spine. Lateral line absent. Gills present (in tufts) or absent. Anal holdfasts either free and strong, or partly fused with last segment. Six anal gills.

Free-living, or constructing elliptical sand-grain cases.

Pupa.—Stout. Antennae shorter than body. Labrum semi-circular or subpentagonal. Mandibles symmetrical or asymmetrical, strong, dentate. Gills and lateral line absent. The postsegmental dorsal plates often on segments 4 and 5, or only on segment 4.

Case composed of sand-grains cemented to stones, the inner silken cocoon imperforate.

Remarks.—Characteristic of swiftly flowing and mountain streams. Hitherto the family is known from Africa only by some larvae assigned to the genus *Agapetus* (*Glossosomatinae*) (Ulmer, 1912, p. 115).

Key to Subfamilies.

1. Tibial spurs 3, 4, 4. Discoidal cell in both wings open. Fore-wing with additional costal cross-vein. Larva with 2nd segment widest, meso- and metanotum corneous, and free anal appendages. Free-living . . . . . *Rhyacophilinae.*
2. Tibial spurs 2, 4, 4. Discoidal cell mostly closed. No additional costal cross-vein. Larva with 5th segment widest, meso- and metanotum (at least in *Agapetus*) with paired chitinous plates, and anal appendages partly fused with last segment. Living in oval sand-grain cases . . . *Glossosomatinae.*

Myspolco n. g.

Imago.—Like *Agapetus* except: fore-wing with fork 5 (and sometimes also fork 1) shortly stalked, 3 and 4 with long stalks. Cross-vein between R and discoidal cell oblique, but R not kinked. In hind-wing Sc longer, more as in *Synagapetus*, with forks 2, 3, 5. Mid leg in ♀ strongly expanded. In ♂ hind tibia not fringed, inner spur normal. Tibial spurs 2, 4, 4. With or without a process on 6th abdominal sternite in ♂.

Larva.—Meso- and metanotum each with two chitinous plates. Tibiae with one spine on inner apex; no ciliated laminae. Two patches of minute scabrosities on sternite of 2nd abdominal segment. Abdominal gills absent; six anal gills. Anal holdfasts partly fused with last segment, with claw and two minute accessory denticles.

Case composed of sand-grains, ovoid, flattened below and open in front and behind, with a "bridge" across the middle connecting the sides. Very frequently the sides of the case are formed by two grains considerably larger than the others.

Pupa.—Mandibles symmetrical, each with two strong teeth on inner margin. Mid tarsus fringed. Presegmental dorsal plates on segments 4–7, postsegmental also on segment 4. With or without a process on 6th abdominal sternite in ♂. Apical segment slightly bilobed.

Case the same as that of larva but without the bridge; on the dorsal surface a few small holes are left between the sand-grains.

Genotype: *M. agilis* n. sp.

Myspolco agilis n. sp.

(Fig. 50 *a–m.*)

Imago.—Genitalia ♂, 9th tergite represented by two slight ridges on the 10th tergite which is apically bifid, in lateral view subtriangular; preanal appendages absent; penis simple, elongate, with two apical spinules; clasper 1-jointed, ovate-reniform in lateral view, with a stout denticle on inner side of apex. ♀ last two segments rather elongate, the terminal segment with a pair of oval processes, each bearing a slender rod-like appendage, which is bent but not (apparently) jointed, ventrally the segment is laterally compressed and laminate. No ventral process on 6th sternite in ♂.

Fore-wings ♂ 3·3–3·3 mm., ♀ 3–4 mm.

Head and thorax dark brown with pale golden hairs. Legs ochraceous. Antennae fulvous. Wings brown with bright golden hairs. Abdomen pinky-brown.

Larva.—3·5–4 mm. in length. Colour of head and chitinised parts fulvous, abdomen pinky-brown. Case 4–5 mm. in length.

Pupa.—Without process on 6th segment in ♂.

Localities.—Groot Drakenstein (A. C. H., March 1931, ♂♂); Wellington Mts. (K. H. B., October 1931, ♂♂); Bain's Kloof, Wellington Mts. (K. H. B. and H. G. W., 1st May 1933, ♂); Du Toit's Kloof, Rawsonville

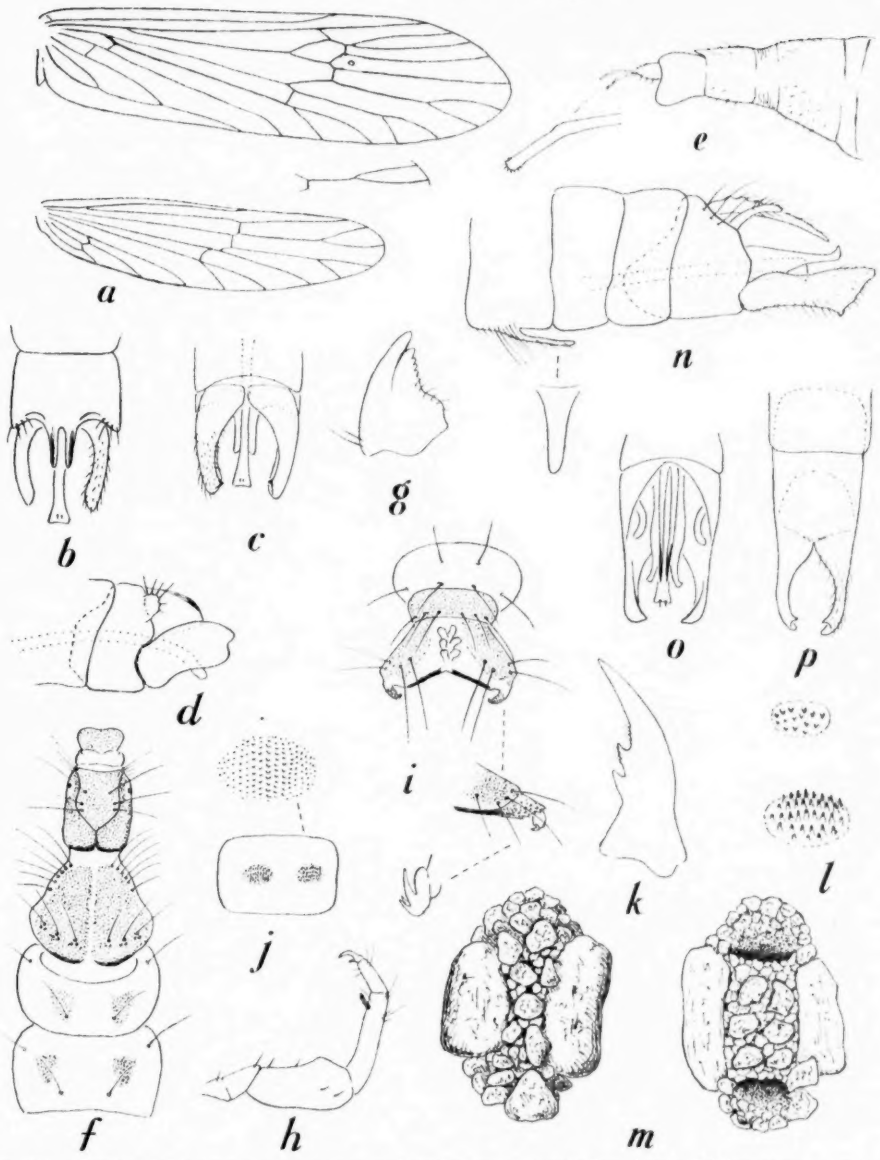

FIG. 50.—*Myspoleo agilis* n. g., n. sp. *a*, fore- and hind-wings, with variation of fork 1 of fore-wing; *b*, *c*, *d*, dorsal, ventral, and lateral views ♂ genitalia; *e*, lateral view ♀ genitalia, with one papilla further enlarged; *f*, head and thorax of larva; *g*, mandible of larva; *h*, fore leg of larva; *i*, posterior segments of larva, showing six anal gills, anal holdfast further enlarged; *j*, 2nd abdominal sternite, with one of the scabrous patches further enlarged; *k*, mandible of pupa; *l*, dorsal plates of segment 4 of pupa; *m*, upper and lower views of larval case. *M. murinus* n. sp. *n*, *o*, *p*, lateral, dorsal, and ventral views ♂ genitalia, with process of 6th sternite in ventral view.

(K. H. B., March 1931, ♂♂); Jonkershoek, Stellenbosch (K. H. B. and H. G. W., June 1932, ♂♂, ♀♀, and February 1933, ♂♂); north slopes of Matroosberg, Ceres Div. (K. H. B. and R. M. Lightfoot, November 1917, ♂♂); French Hoek Mts. (H. G. W., October 1932, larvae, ♀♀, and K. H. B., December 1932, ♂♂); Gt. Winterhoek Mts. (K. H. B. and H. G. W., November 1932, larvae, pupae, ♂♂, ♀♀); Bosch Kloof, Keeromberg, Worcester (H. G. W., January 1933, pupae, ♂♂, ♀).

Remarks.—This agile little Caddis-fly is common on rocks in mid-stream and along the margins, running swiftly just above the water-line, and when alarmed taking short flights to neighbouring rocks.

Myspoleo murinus n. sp.

(Fig. 50 *n–p.*)

Imago.—Similar to *agilis*, but with a ventral process on 6th sternite in ♂, and different genitalia. 9th + 10th tergites represented by two slender acute processes; preanal appendages slender, curved; one pair of titillators (or upper penis sheath), apically truncate and upturned; clasper more elongate.

Fore-wing ♂ 3–3·3 mm., ♀ 3·3–3·5 mm.

Colour as in *agilis*.

Larva and pupa as in *agilis*, but the latter with process on 6th sternite in ♂.

Localities.—Hottentots Holland Mts., 1500–4000 feet (K. H. B. and H. G. W., November 1932 and January 1933, larvae, pupae, ♂♂, ♀♀); River Zonder End Mts. (H. G. W., January 1933, pupae, ♂♂).

Family Hydroptilidae.

Ulmer, 1907, p. 216. Lestage, 1919A, p. 258; 1921, p. 432 (larva and pupa).

Imago.—Tibial spurs various (1, 2, 4 or 0, 2, 4, or 0, 2, 4 or 0, 3, 4). Legs usually with tibiae and tarsi fringed with long hairs. Mid leg ♀ not dilated. Antennae usually stout and shorter than fore-wing. Ocelli usually present. Maxillary palp 5-jointed ♂ ♀, first two joints very short, 5th not segmented, not flexible. Labial palp small. Wings usually elongate-lanceolate, narrow, apically acute, with long marginal fringes, especially on hind-wing, densely pubescent and with long, thickened, upstanding hairs; veins thick, but often difficult to trace, neuration regular or irregular and incomplete. Cross-veins usually indistinct.

Genitalia ♂, preanal appendages absent; 10th tergite forming a more or less membranous plate (except *Oxyethira*); claspers 1-jointed. 6th or 7th (or both) abdominal sternite with process, often strongly setose, and often reaching apex of abdomen. ♀ with two apical cerci.

Egg-mass.—Cemented to stones under water (Ulmer, 1909A, p. 204).

Larva.—Campodeiform. 4th–6th abdominal segments widest. Antennae distinct. Mandibles asymmetrical, left with internal tuft, right knife-like. Maxillary palp 5-jointed. Pro-, meso-, and metanotum corneous. No prosternal spine. Legs subequal or mid leg and especially hind leg much longer than fore leg. Lateral line and gills absent. Sometimes with abdominal processes, which may be branchial in function. Anal appendages short.

Case much larger than larva, usually flat, variously shaped (flask-shaped, fusiform, reniform), open at both ends, composed of secreted silk, or with sand-grains or vegetable matter.

Pupa.—Antennae shorter than body. Mandibles strong, base broad, apex acute, not dentate. Only first three joints of mid tarsi fringed. Presegmental dorsal plates on segments 3–6 or 7, usually elongate, postsegmental on segments 3–5, usually small, round. Lateral line and gills absent. Apical segment conical (♀) or lobed (♂).

Case the same as that of larva, closed, and anchored to some support, usually by silken threads, which end in small discs.

Remarks.—Minute Caddis-flies, greatly resembling Microlepidoptera, inhabiting running and stagnant water. Two species were hitherto definitely known from Africa, and some uncorrelated larvae.

Key to the African genera.

1. Tibial spurs 0, 2, 4. Fore-wing with anal lobe and forks 2 and 3. Hind-wing with fork 2. Ocelli absent. *Hydroptila.*

2. Tibial spurs 0, 3, 4. Fore-wing without anal lobe.
   a. Ocelli absent. Fork 3 present in both wings . . . *Catoxyethira* (Belgian Congo).
   b. Ocelli present. No apical forks . . . . . *Argyrobothrus.*

Gen. *Hydroptila* Dalman.

Ulmer, 1907, p. 222; 1912, p. 83. Lestage, 1921, p. 445 (larva and pupa).

Imago.—Tibial spurs 0, 2, 4. Ocelli absent. Posterior warts on head sometimes produced into rather elongate lobes. Fore-wing elongate lanceolate, apex pointed, with narrow anal lobe (frequently curled inwards and difficult to see); Sc and R confluent, forks 2 and 3 present, faint hyaline cross-veins between R and M_1, and in a nearly straight line between M, Cu, and A. Thyridial cell present. Hind-wing narrower than fore-wing, costal margin sinuous, a cross-vein between R and M; only fork 2 present. Usually a process on 7th sternite in ♂.

Larva.—Abdomen without lobe-like processes; all its segments membranous except a plate on 9th tergite. Hind legs 1½ times length of fore legs.

Case composed of sand-grains, or secretion only, sometimes ornamented with algae, diatoms, etc., kidney- or bean-shaped, laterally compressed.

Pupa.—Mandibles not dentate. Presegmental dorsal plates on segments 3–7, postsegmental also on segments 3–5.

Case the same as that of larva, fixed by two adhesive discs, sessile or shortly stalked.

Remarks.—The genus is found in Europe, North America, and North Africa, but is not considered entirely homogeneous. One species is known from Tanganyika (Ulmer, 1912).

Hydroptila capensis n. sp.

(Fig. 51 *a–i*.)

Imago.—Antennae with whorls of thickened hairs. Fore-wing with R_3 nearly straight, stalk of fork 2 very close to M_1 at one place. Thyridial cell very long. Cu_1 and Cu_2 distally confluent. A short spiniform process on 7th sternite in ♂.

Genitalia ♂, 10th tergite lamellate, membranous, the lateral apices upturned, the median line chitinised; penis simple, elongate, with corkscrew titillator (within the genital segment); a pair of twisted, apically truncate titillators; claspers apically curved downwards, with a short, laterally projecting curved process near their bases; 9th sternite with short spiniform process between bases of claspers.

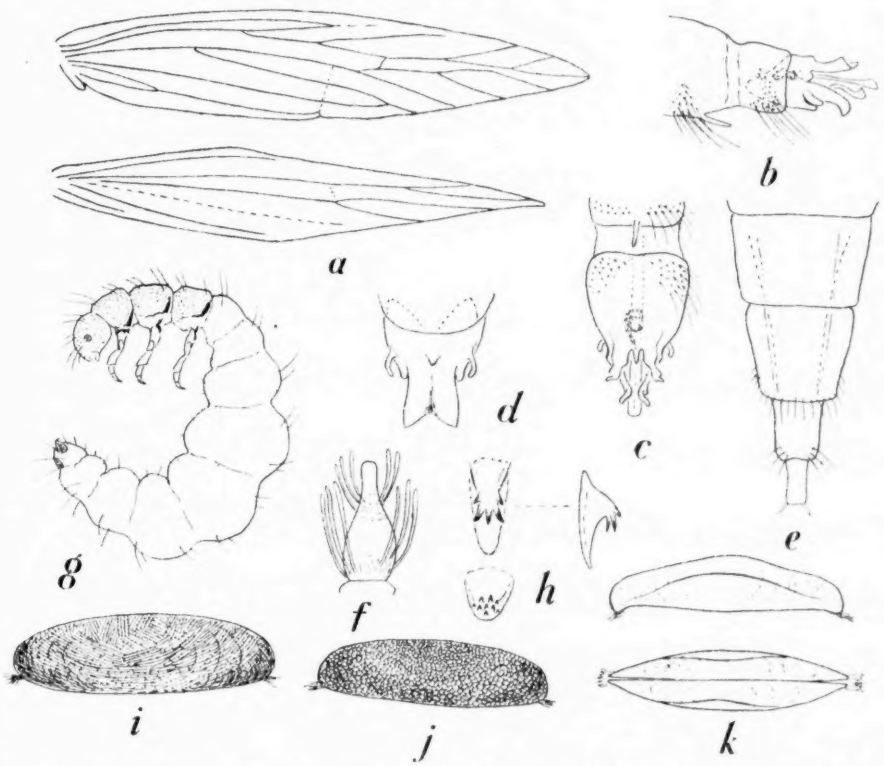

Fig. 51.- *Hydroptila capensis* n. sp. *a*, fore- and hind-wings; *b*, *c*, lateral and ventral views ♂ genitalia; *d*, dorsal view of 10th tergite; *e*, dorsal view of end of abdomen ♀; *f*, apex of antenna, only some of the thickened setae drawn in; *g*, larva; *h*, pre- and postsegmental dorsal plates of 5th segment of pupa, with the former also in lateral view; *i*, case, composed of filaments of *Spirogyra*. *Hydroptila* sp. *j*, case, composed of sand-grains. *Hydroptila* sp. *k*, case, composed of secretion, lateral and dorsal views.

Fore-wing ♂ 2·75 mm., ♀ 3 mm.

Head and thorax with black hairs. Fore-wing with black hairs, the margin in pterostigmal area and around the tip with fawn-coloured hairs, fringe black, except at the pterostigmal area, where it is fawn. Hind-wing with black fringe. Antennae grey. Legs pale buff.

Larva.—Colour greenish. Case 4–5 mm. in length, elliptical, compressed, composed of secretion covered with pieces of green alga (*Spirogyra*).

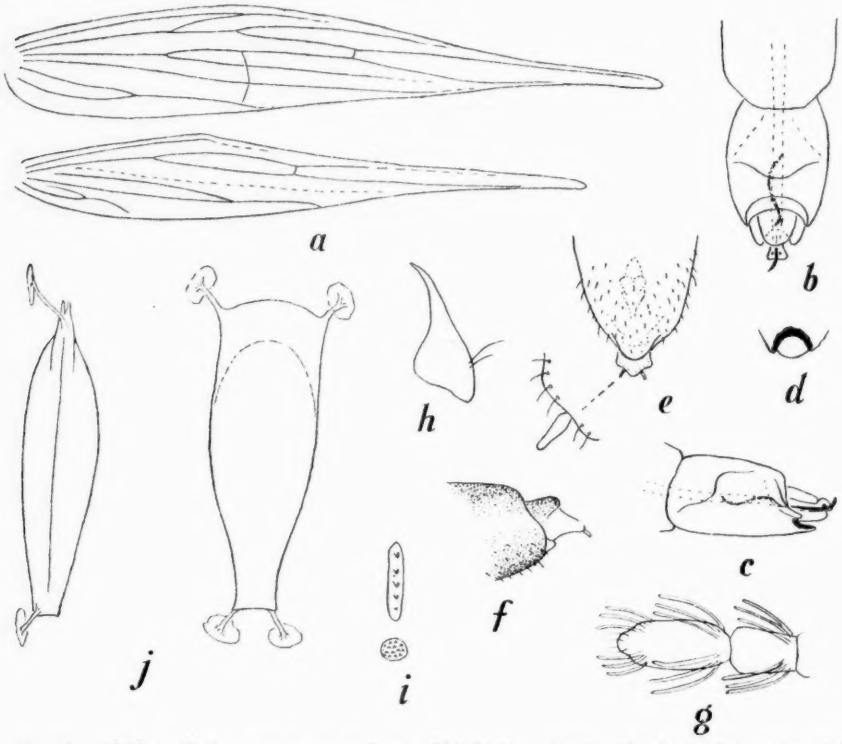

FIG. 52.—*Argyrobothrus velocipes* n. g., n. sp. *a*, fore- and hind-wings; *b*, *c*, dorsal and lateral views ♂ genitalia; *d*, ventral view of apex of terminal segment; *e*, *f*, dorsal and lateral views ♀ genitalia; *g*, apex of antenna, only some of the thickened setae drawn in; *h*, mandible of pupa; *i*, pre- and postsegmental dorsal plates of 5th segment of pupa; *j*, case in lateral and dorsal view.

Pupa.—Colour greenish. Mandibles as in *A. velocipes* (fig. 52). Presegmental dorsal plates strongly uncinate, with three denticles, and another pair just above them, postsegmental plates small, round, with about 6–8 denticles.

Case the same as that of larva, attached to underside of stones by two sessile attachment discs, at first green, but gradually becoming brown as the alga dies.

Localities.—Table Mt. (Orange Kloof) (K. H. B., March 1933, larvae, pupae, ♂, ♀ bred); Du Toit's Kloof, Rawsonville (K. H. B., March 1932, pupae); Montagu (K. H. B., October 1919, ♂♂, ♀♀); Jonkershoek, Stellenbosch (K. H. B. and H. G. W., June 1932, 1 ♀); Warmbaths, Citrusdal (K. H. B., September 1932, 1 ♀).

Remarks.—The larvae live amongst masses of *Spirogyra*, and the case is most beautifully constructed of filaments of this alga.

Argyrobothrus n. g.

Imago.—Tibial spurs 0, 3, 4. Ocelli present. An oval wart in front of each lateral ocellus. Antennae with whorls of thickened hairs. Wings long and narrow, especially hind-wing, apices subulate and acute. No apical forks. In fore-wing R confluent with Sc distally. Cross-veins between R_{4+5} and M_1 and between

M, Cu_1, and Cu_2, and A, these three in nearly a straight line; all cross-veins very faint. In hind-wing one faint cross-vein. Fore-wing without anal lobe. Abdomen without any processes.

Larval case flask-shaped, the anterior end larger.

Pupa.—Mandible with slender apex, smooth. Presegmental dorsal plates on segments 3–7, narrow elongate, each with 5–6 denticles in a longitudinal row, postsegmental also on segments 3–5, small, round, each with several denticles. Gills and lateral line absent. Apex of abdomen rounded. Mid tarsus fringed.

Case the same as that of larva, affixed to weed and other objects by a stalked disc at each corner.

Argyrobothrus velocipes n. sp.

(Fig. 52.)

Imago.—Head and thorax brown with pale golden hairs. Ocelli dark. Legs and antennae pale ochreous. Wings pale fawn, wing fringes of fore-wing with alternate light and dark patches, fringe around wing-tip dark. Fringe of hind-wing pale greyish.

Fore-wing ♂ 3 mm., ♀ 3·5–4 mm.

Genitalia ♂, terminal segment rather elongate, dorsally widely emarginate, ventrally with semi-circular excision, whose margin is strongly chitinised. A dorsal ring of chitin extends laterally, where it forms a slight projection; 10th tergite an oval plate; penis slender, apically expanded, with a slender upturned spiniform titillator, and a very feeble corkscrew-like titillator. ♀ apex subpentagonal, with a pair of minute appendages.

Case up to 5 mm. in length.

Localities.—Silvermine Valley, Kalk Bay, Cape Peninsula (A. C. H., July and October 1931, ♀♀). Jonkershoek, Stellenbosch (K. H. B., May 1931, ♂♂; A. C. H. and F. G. Chaplin, November 1932, pupae). Table Mt., near Reservoirs (K. H. B., July 1919, and K. H. B. and H. G. W., October 1932, and February 1933, ♂♂, ♀♀). Gt. Winterhoek Mts. (K. H. B., November 1932, 1 ♀).

Remarks.—The Table Mt. specimens were observed in a marshy situation, running very rapidly up and down the reeds, and occasionally making short jerky flights.

Hydroptilid cases not correlated.

Du Toit's Kloof, Rawsonville (K. H. B., March 1932). Elliptical, compressed, with two sessile adhesive discs, composed of minute sand-grains, attached to stones. Length 3 mm. Larva with pro-, meso-, and metanotum corneous. Pupa 2 mm. in length, tibial spurs 0, 2, 4. No ocelli. ♀ with elongate terminal abdominal segment as in *Hydroptila capensis* (fig. 51 *j*).

Naudesberg, Worcester (K. H. B., August 1932, larvae); Jonkershoek, Stellenbosch (K. H. B., February 1932, pupae); Junction Pool, Dwars and Berg Rivers, Drakenstein (K. H. B., December 1932, larvae and empty cases).

Brown, resembling a caraway seed; fusiform, flattened ventrally, with slight lateral keels, two sessile attachment discs, composed of membranous secretion, attached to stones. Length 2·5–2·75 mm. Larva with pro-, meso-, and metanotum corneous, eyes large, situate dorsally in the posterior third of head. Pupa with large eyes and tibial spurs 0, 2, 4 (fig. 51 *k*).

BIBLIOGRAPHY.

Banks, N., 1920, "New Neuropteroid Insects," Bull. Mus. Comp. Zool. Harv., vol. lxiv, p. 3; (Trich.) pp. 342–362, pls. i–vii.

Brauer, F., 1876, "Beschreibung neuer und ungenügend bekannter Phryganiden und Oestriden," Verh. zool.-bot. Ges. Wien, vol. xxv, pp. 69–78, pl. iv.

Hagen, H., 1864, "Ueber Phryganiden-Gehäuse," Stettin. Entom. Zeit., vol. xxv, pp. 113–144 and 221–263.

Lestage, J. A., 1919, "Notes sur quelques Névroptères (Ephémères et Trichoptères) du Congo Belge," Rev. Zool. Afr., vol. vi, pt. ii (Trich.), pp. 195–204, 5 figs.

Lestage, J. A., 1919a, "Les Trichoptères d'Afrique, Catalogue synonymique et systématique des espèces connues," *ibid.*, vol. vi, pt. iii, pp. 251–335.

Lestage, J. A., 1921, In Rousseau, E., "Les Larves et Nymphes aquatiques des Insectes d'Europe," vol. i (Trich.), pp. 343–964, figs. 104–344. Brussels.

Lestage, J. A., 1922, "Notes sur *Dipseudopsis simplex* Ulm.," Rev. Zool. Afr., vol. x, 2, pp. 212–214, 1 fig.

Martynow, A., 1909, "Les Trichoptères de la Sibérie. 1 partie. Les fam. Phryganeidae et les Sericostomatidae," Ann. Mus. Zool. Acad. Imp. St. Petersb., vol. xiv, 3–4, pp. 223–255, figs. 1–23 (Russian and English).

Mosely, M. E., 1931, "Some new Trichoptera from Africa and British Guinea," Tr. Entom. Soc. Lond., vol. lxxix, 3, pp. 545–551, figs. 1–21.

Mosely, M. E., 1931a, "The genus *Diplectronella* Ulmer," Ann. Mag. Nat. Hist., (10), vol. viii, pp. 195–205, figs. 1–13.

Mosely, M. E., 1932, "Some new African Leptoceridae (Trichoptera)," *ibid.*, (10), vol. xi, pp. 297–313, figs. 1–29.

Mosely, M. E., 1932a, "More African Leptoceridae (Trichoptera)," Stylops, vol. i, 6, pp. 128–134, figs. 1–18.

Mosely, M. E., 1932b, "New Exotic Species of the genus *Ecnomus* (Trichoptera)," Tr. Entom. Soc. Lond., vol. lxxx, 1, pp. 1–17, figs. 1–45.

Mosely, M. E., 1932c, "Corsican Trichoptera and Neuroptera, 1931," Eos. Rev. Espan. Ent., vol. viii, pp. 165–184, figs. 1–18, pls. iv, v.
Mosely, M. E., 1932d, "Trichoptera. Contrib. Faune Mozamb. voyage de M. P. Lesne," Mem. Est. Mus. Zool. Univ. Coimbra, 1932, Ser. 1, No. 64, pp. 3–7, pl. 1.
Müller, F., 1880, "Sobre as Casas construidas pelas Larvas de Insectos Trichopteros da Provincia de Santa Catharina," Arch. Mus. Nac. Rio de Janeiro, vol. iii (1878), pp. 99–124, pls. 8–10; Supplement, pp. 125–134, pl. 11; explan. figs., pp. 210–214.
Navas, R. P. L., 1915, "Notes sur quelques névroptères du Congo Belge," Rev. Zool. Afr., vol. iv (Trich.), pp. 181–182, fig. 6.
Navas, R. P. L. 1927, "Névroptères d'Egypte et de Palestine," Bull. Soc. Roy. Entom. Egypt, vol. xix [1926] (Trich.), pp. 211–216, figs. 9, 10.
Navas, R. P. L., 1930, Mem. Pont. Acc. Sci. Nuovi Lincei., vol. xiv, p. 417 (quoted from Ulmer, 1931).
Navas, R. P. L., 1930a, "Insectes du Congo Belge (ser. 4)," Rev. Zool. Bot. Afr., vol. xix, 3/4 (Trich.), pp. 323–336, figs. 39–50.
Navas, R. P. L., 1931, "Insectes du Congo Belge (ser. 5)," *ibid.*, vol. xx, 3 (Trich.), pp. 274–279, figs. 60–63.
Navas, R. P. L., 1931a, "Insectes du Congo Belge," (ser. 6), *ibid.*, vol. xxi, 2 (Trich.), pp. 138–144, figs. 74–79.
Navas, R. P. L., 1932, "Insectes du Congo Belge" (ser. 7), *ibid.*, vol. xxii, 3 (Trich.), pp. 288–290, figs. 86, 87.
Silfvenius, A. J. (=Siltala), 1906, "Über den Laich der Trichopteren," Acta Soc. F. et. Fl. Fenn., vol. xxviii, No. 4, pp. 3–128, pls. 1, 2.
Ulmer, G., 1904, "Über die von Herrn Prof. Y. Sjöstedt in Kamerun gesammelten Trichopteren," Ark. Zool., vol. i, 3, pp. 411–323, figs. 1–12.
Ulmer, G., 1905, "Neue und wenig bekannte Trichopteren der Museen zu Brüssel und Paris," Ann. Soc. Entom. Belg., vol. xlix, 1, pp. 17–42, figs. 1–31.
Ulmer, G., 1905a, "Neue und wenig bekannte aussereuropäische Trichopteren, hauptsächlich aus dem Wiener Museum," Ann. K. K. Naturh. Hofmus. Wien, vol. xx, pp. 59–98, figs. 1–75.
Ulmer, G., 1905b, "Zur Kenntniss aussereuropäischer Trichopteren," Stett. Entom. Zeit. Jhrg., vol. lxvi, 1, pp. 3–119, pls. 1–4.
Ulmer, G., 1906, "Neuer Beitrag zur Kenntniss aussereuropaeischer Trichopteren," Notes Leyden Mus., vol. xxviii, 1, pp. 1–116, figs. 1–114.
Ulmer, G., 1907, "Trichopteren," Genera Insectorum, fasc. 60.
Ulmer, G., 1907a, "Neue Trichopteren," Notes Leyden Mus., vol. xxix, 1, pp. 1–53, figs. 1–72.
Ulmer, G., 1908, "Trichoptera," Schwed. Kilimandjaro-Meru Exp., vol. ii, 13, pp. 1–10, 1 pl. and 5 text-figs. (volume dated 1910).
Ulmer, G., 1909, "Trichopteren von Madagascar und den Comoren," Wiss. Ergeb. Voeltzkow Reise, vol. ii, 4, pp. 357–363, figs. 1–19.
Ulmer, G., 1909a, "Trichoptera," Die Süsswasserfauna Deutschlands, Hft. 5/6.
Ulmer, G., 1910, "Trichopteren, Percy Sladen Trust Exp., Ind. Ocean, 1905"—III, Tr. Linn. Soc. Lond., 2nd ser., Zool., vol. xiv, pp. 41–54, pls. 3, 4.
Ulmer, G., 1910a, "Über Bernsteintrichopteren," Zool. Anz., vol. xxxvi, pp. 449–453.
Ulmer, G., 1911, "Zwei neue Arten der Trichopteren-Gattung *Dipseudopsis* aus Afrika," Rev. Zool. Afr., vol. i, 2, pp. 253–255, figs. 1, 2.
Ulmer, G., 1912, "Trichopteren von Äquatorial-Afrika," Wiss. Ergeb. D. Zentral-afrika Exp., IV., Zool., 2, pp. 81–125, figs. 1–50 (volume dated 1913).
Ulmer, G., 1913, "South African Trichoptera," Ann. S. Afr. Mus., vol. x, pp. 189–191, 1 fig.
Ulmer, G., 1922, "Trichopteren aus den Ägyptischen Sudan und aus Kamerun," Mitt. Münch. Entom. Ges. Jhrg., 12, pp. 47–63, figs. 1–25.
Ulmer, G., 1923, "Trichopteren aus den Ägyptischen Sudan und aus Kamerun" (continued), *ibid.*, 13, pp. 9–20, figs. 26–36.
Ulmer, G., 1929, "Über einige, hauptsächlich asiatische, Ephemeropteren und Trichopteren aus der Sammlung R. McLachlan," D. Entom. Zeit., 1929, Hft. 3, pp. 161–195, figs. 1–32.
Ulmer, G., 1930, "Entomological Expedition to Abyssinia, 1926–1927; Trichoptera and Ephemeroptera," Ann. Mag. Nat. Hist., (10), vol. vi, pp. 479–511, figs. 1–28.
Ulmer, G., 1931, "Trichopteren von Afrika," D. Entom. Zeit., 1931, Hft. 1, pp. 1–29, figs. 1–30.
Walker, F., 1852, Catalogue of Neuropterous Insects in the British Museum, Pt. 1, London, pp. 77 and 91.

Published while present paper in the press:—
Mosely, M. E., 1933, "The Genus *Pseudoleptocerus* Ulmer," Ann. Mag. Nat. Hist. (10), vol. xi, pp. 537–547, pl. 10, text-figs. 1–14.
Mosely, M. E., 1933, "A Revision of the Genus *Leptonema*," Brit. Mus., London.